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"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH

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THURSDAY, SEPTEMBER 2, 1915.

THE EXAMINATION OF HYDROCARBON OILS.

The Examination of Hydrocarbon Oils and of Saponifiable Fats and Waxes. By Prof. D. Holde. Authorised translation from the fourth German edition by Prof. E. Mueller. Pp. xv + 483. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1915.) Price 21*s*. net.

THE important part played by liquid fuel, both for steam raising and in the internal combustion motor, has focussed a large amount of attention upon the examination of hydrocarbon oils for commercial use, whilst the many "cracking" processes that have been introduced to supplement the supply of the lighter fractions of petroleum for motor purposes have considerably increased the interest felt in the somewhat involved actions, partly analytic and largely synthetic, that under the influence of heat and pressure bring about such profound changes in the characteristics of the oils.

Under these conditions any book dealing with the analysis of such oils would have been welcomed, and Dr. Holde has made the fourth edition of his work on the examination of hydrocarbon oils more attractive and at the same time more useful by introducing chapters on the tars obtained by the distillation of coal, lignite, shale, and peat, on saponifiable fats and the technical products prepared from them, and on waxes.

The first chapter occupies more than half the book, and deals with petroleum and petroleum products. After touching upon the occurrence, chemical composition, and formation of petroleum, there is an excellent section on its physical examination, followed by one on its chemical treatment, in which the flash-point is apparently given as the measure of the inflammability of the oil, the paragraph being headed "Inflammability," whilst a few pages later another paragraph is devoted to "Burning Point." The chemist knows perfectly well what is meant by flash and burning points, but the non-initiated, when told that naphtha has a flash point of $-21°$ C. and a burning point of $-19°$ C., gets an uncomfortable feeling that the material is too inflammable to have anything to do with, and before it is possible to clear up properly the muddlement that these terms have created it will be necessary to determine the igniting points of the various hydrocarbons present in petroleum, which vary from 400° C. to 700° C.

In dealing with the calorific value of naphthas for internal combustion motors the reader is told that "it is determined in a bomb," but no details are given as to how the dangers and difficulties of such a determination with a highly volatile spirit are to be got over. In discussing Hensler and Engler's combustion method for the determination of sulphur in oils, the dweller in a manufacturing town will be amused to read that since the laboratory air often contains sulphur, the tubes to supply the air for combustion are led into the open air; as 10 to 12 grams of oil are burnt in five hours, the sulphur from the air of even London would amount to more than the oil probably contained.

In many technical applications the book is scarcely up to date; for instance, we are told that "an attempt has been made" to cover the surface of roads with tar or oil, and later, "the tar applied hot is brushed into the street." The reader is also informed on p. 44 that "the gasoline used in pleasure vehicles should have no more than 5 per cent. of those components which boil

above 100° C., since otherwise the engine will frequently misfire"; considering that Pratt's spirit usually gives a little under 60 per cent., distilling below 100° C., and many petrol substitutes considerably less, this seems a misleading statement.

On p. 45 we are told that "the vapour pressure must be considered in storing naphtha and other inflammable liquids," but it is now being recognised that the determination of this factor is also of the greatest importance in forming a sound conclusion as to the ease of starting and flexibility in running with a motor spirit, as the amount of vapour given off at atmospheric temperatures governs the formation of the explosive mixture in the cylinder when starting from cold.

Directions are given for determining the vapour tension by introducing the petrol into the Torricellian vacuum above the barometric column in a 10 mm. diameter tube, but a far more simple and practical method is to use the pressure tube devised by Sir Boverton Redwood and Captain Thomson, which is adopted for testing the pressures developed in vessels containing petrol.

Several pages are devoted to the viscosity of oils and testing their lubricating value, and also to the setting point and fluidity of oils, their value for gas-making and tendency to resinification.

The book is, like most of the technical works of German origin, a model of abstracting, and invaluable as giving full references to original work, but its utility is discounted in the laboratory by the absence of practical detail.

Chapter ii. is devoted to natural asphalt, and contains much useful information on the subject; chapter iii. deals with ozokerite and Montan wax; whilst in chapter iv. we come to the important subject of the tars obtained by the distillation of coal, lignite, shale, and peat.

The attention devoted to the recovery of the coal-tar products in Germany led one to hope that this part of the book would contain much valuable information, but unfortunately the subject is not treated very fully, and points of such importance as the differences in tars due to variations in the temperature of carbonisation receive but scanty notice, whilst the use of the products of tar distillation is dismissed with the curt remark that "these are of great importance in the preparation of dye-stuffs and of pharmaceutical products." It might have been expected that special attention would have been devoted at the present time to the detection, estimation, and purification of those tar products used in the production of high explosives, but even the fact that it is the source of the most important explosives of the day is not mentioned.

The saponifiable fats and their technical products are a very useful section of the book, which ends with a chapter on waxes. Prof. E. Mueller is to be congratulated on the translation of the original German work, and the type, illustrations, and general style are of the excellence always found in Messrs. Wiley's technical publications.

ELECTRICAL ENGINEERING.

(1) *Continuous-current Electrical Engineering.* By W. T. Maccall. Pp. viii+466. (London: University Tutorial Press, Ltd., 1915.) Price 10*s.* 6*d.*

(2) *Single-phase Electric Railways.* By E. Austin. Pp. xiv+303. (London: Constable and Co., Ltd., 1915.) Price 21*s.* net.

(1) MR. MACCALL'S book is well above the standard usually found in books which cover such a wide field, and it can be thoroughly recommended, both to engineers and to students. To the latter, the large selection of questions will be of especial value. The book covers the ground indicated by its title about as thoroughly as could be expected in a volume of its size and price; the most noteworthy omission is the subject of primary batteries. More might have been said about electric heating, a little about electric cooking, and electric furnaces might at least have been mentioned.

The chapters on illumination and lamps are very good indeed, and contain little that we would wish to alter. But those on machines, although quite up to the standard of most text-books, are certainly less satisfactory. Here and there the matter is rather weak. Thus the portion dealing with generator characteristics does not show that real grip of the subject which an instructor ought to have. Another point is the geometry of the armature winding diagrams. A developed diagram is shown with the poles behind, the commutator *below,* and the numbers running from left to right; while a radial diagram has clockwise rotation of the numbers. These are not consistent with one another.

We do not think the author has ever tried to separate the no-load losses of a machine in any of the ways he has described, or we should have seen some doubts expressed as to the validity of some of them. In fact, he would probably have found, as we ourselves once did, that the "friction" alone, as determined from the constant speed experiment, *exceeds* the "friction+hysteresis" given by the constant flux experiment. In short, this method won't work, for it assumes that the frictional torque is the same at all speeds, which is very far from the truth. The running down test can be carried out much more simply than in the manner described, and it can be modified

so as to give a complete analysis of the losses in about half an hour after getting the machines into a steady condition.

We are flattered by the graceful acknowledgment that our mode of numbering the illustrations has been adopted, but we would have greatly preferred that in a much more important direction the author had followed the methods we advocate, but cannot claim to have originated. We refer to the practice of making the algebraic symbols stand for *things* and not merely for numbers, so that the formulas will apply irrespective of units. Mr. Maccall seems unable to discuss principles apart from some particular units, with the result that his mathematics is horribly complicated by numbers which have nothing to do with the facts, but arise from the unfortunate, although perhaps customary, choice of units. In some cases we are treated to separate deductions of formulas for inch and metric measure, instead of one formula with two sets of constants. As we said on a former occasion, the laws of nature were exactly the same ages before man ever discovered anything about them, much less invented units in which to express his measurements concerning them. *Make the symbols stand for things and the units will look after themselves.* Formulas will then represent *facts*, and not merely particular numerical relations.

We like the author's special symbol for "number of turns," but we object to making his other new symbol do double duty by using it both for "current × turns" and for the name of the unit "ampere-turn."

For the new edition, which we confidently expect, we hope that the publishers will adopt a paper suitable for reproducing the half-tone blocks. Fortunately, these form only a small proportion of the illustrations, but where they do occur they entirely spoil the appearance of the book, while at the same time they are seldom sufficiently distinct to be of any real use.

(2) "Single-phase Electric Railways" gives an outline description, with leading data, of all the important lines of this type which have so far been constructed. Although most of the matter has already been published in the columns of the *Engineer,* it is convenient to have it all collected together for ready reference. For that reason, it is unfortunate that the author has decided not to deal fully with the motor itself, and also that he has not included a great deal more data regarding the operating costs, of which much has been made public during the past few years.

The book is abundantly and well illustrated by drawings and photographs; indeed, the latter take such a very prominent place as to almost form the *raison d'être* of the book. The overhead construction is taken in fairly full detail, but the particulars of the motors and controlling gear are somewhat meagre. Diagrams of connections are certainly there, but the written description is generally too slight, except for the expert.

The first chapter of three pages is mainly historical, but just touches on the thorny battle of the systems. More eloquent than all the opinions of the author and the experts is the fact, brought out in a recent number of the *General Electric Review*, that since the advent of the high-voltage continuous-current system, the mileage of single-phase railways has been practically stationary, while that of the continuous-current system has gone up by leaps and bounds, and now far surpasses its rival. It would have been far better if this chapter had given an account of the general principles underlying single-phase railway working, and a closely reasoned account of the difficulties arising from it, the way in which these have been overcome, and the relative advantages and disadvantages of the system. A comparison of the solutions found for these difficulties in the various lines described further on would have served to weld the book into a homogeneous whole, instead of leaving it in twenty-three water-tight compartments (one for each line described), with no connection between them but the common title to the whole book.

We may conclude by saying that to the expert and to the student of railway engineering, the book will be of especial value as a work of reference, diminished although that is by the lack of references to other publications. Others may find it interesting, for the style is good and the matter is made as readable as a catalogue (for such it really is) well can be.

DAVID ROBERTSON.

THE LIMITATIONS OF SCIENCE.

(1) *The Limitations of Science.* By Prof. L. T. More. Pp. vii + 268. (New York: H. Holt and Co., 1915.) Price $1.50 net.

(2) *The Magic of Experience.* A Contribution to the Theory of Knowledge. By H. Stanley Redgrove. Pp. xv + 111. (London: J. M. Dent and Sons, Ltd., 1915.) Price 2s. 6d. net.

(1) PROF. MORE has written a study from a conservative point of view of the limitations of science as shown in modern physical views. "Will the results of experiment made objectively which must, however, be interpreted subjectively, fail in their turn as criteria of truth?" (p. 2). "Science, . . . like philosophy, has no ontological value. Should not the men of science clearly recognise this fact, and confine

their effort to the legitimate function of science—the discovery of natural phenomena and their classification into general laws by logical mathematical processes?" (p. 31).

The account of the growth of the mechanistic view in science and of atomism, and the criticism of them and development of a science of energetics by Rankine, Mach, Duhem, and Ostwald, are fairly adequate, and direct attention to some points—notably in Rankine's attitude—which have been forgotten by most people. It is rather disappointing to find no mention of Stallo's extremely important work in the theory of knowledge, especially when we see that the second chapter is headed "The Metaphysical Tendencies of Modern Physics," and read such passages as that on p. 70. But Prof. More's problem is not quite the same as Stallo's. In Stallo's time physicists vigorously denied that their theories had a metaphysical basis, and it was Stallo's purpose to show that the physicists were mistaken in their denial. But at the present time such a theory as Larmor's has an avowedly philosophical background. The great obligation of modern physics to Descartes is seen from the admirable discussion of Descartes' physical system in chapter iii. "A comparison of his [Descartes'] postulates and conclusions with those of our modern theory shows them to be almost identical, if we change his antiquated knowledge and his discarded metaphysical language into modern terminology" (p. 67; *cf.* pp. 98, 101).

The fourth chapter is a reprint of an article in the *Philosophical Magazine*, and, under the heading "The Scientific Method," contains a very sensible critical review of recent physical theory. Prof. More himself advances a hypothesis to make the ratio e/m agree with the experimental evidence (p. 140). The fifth chapter is on "The Classical and the New Mechanics," and here Prof. More concludes that, if we finally adopt the most modern thesis that matter is the manifestation of energy, we are acknowledging that "the guides to knowledge are now to be found in those subjective impressions which must depend on the individual, and vary with him. . . . The classical natural philosophy of Newton and Galileo has drifted into that transcendental symbolism which is apt to take place when German thinkers become the leaders in philosophy" (p. 163). The sixth chapter is on "Skepticism and Idolatry in Science," and here some of the writings of Poincaré and Sir Oliver Lodge make admirable illustrations; and the seventh chapter is on "Science as the Arbiter of Ethics." This is a thoughtful book, and though easy to read, is not superficial.

(2) Mr. Redgrove's book makes a great point of the fact that experience is subjective, as Berkeley pointed out, and of which Mach has made such illuminating use in physics. Of course materialism becomes easily refutable from this point of view. Mr. Redgrove leans to the mysticism of John Smith the "Cambridge Platonist," Boehme, and Swedenborg, but—and this would surprise some after that—he adopts what seems to be a very sensible attitude in his emphasis on the validity of the laws of nature, and the fallacy of "Christian Science" metaphysics. Mr. Redgrove follows Mill in thinking that mathematical truth is merely founded on experience, and holds that absolute truth is unknown and unknowable. In spite of this we may approach truth, "just as a mathematical series may for ever progress towards some limit which it never reaches" (p. 86). The mathematical illustrations seem to be quite irrelevant: we might just as well illustrate a fanciful doctrine that we can attain the limits of knowledge over and over again in our lives, and yet approach no definite knowledge, by instancing the function sin x as x proceeds to infinity along the real axis. ϕ.

RECENT ELECTRICAL BOOKS.

(1) *Arithmetic of Alternating Currents.* By E. H. Crapper. Pp. vii+208. (London: Whittaker and Co., 1915.) Price 2*s.* 6*d.* net.

(2) *Constant-voltage Transmission: a Discussion of the Use of Synchronous Motors for Eliminating Variation in Voltage in Electric Power Systems.* By H. B. Dwight. Pp. vii+115. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1915.) Price 5*s.* 6*d.* net.

(3) *Alternating-current Work: an Introductory Book for Engineers and Students.* By W. P. Maycock. Pp. xxiii+415. (London: Whittaker and Co., 1915.) Price 6*s.* net.

(4) *Experimental Electricity and Magnetism.* By M. Finn. Pp. x+436. (London: G. Bell and Sons, Ltd., 1915.) Price 4*s.* 6*d.*

(1) PROF. E. H. CRAPPER'S book can be recommended to all desiring to obtain a thorough working knowledge of the everyday calculations which have to be made by alternating-current engineers. The lengthy experience the author has had in training electrical engineers has convinced him that the only way to master the subject is to acquire facility in solving the types of numerical problems which occur in practice. There are 232 examples in the book. The answers to all of them are given, and fifty are worked out in full. They are arranged in order of difficulty, and none of them make excessive demands on the

knowledge or ability of the student. We have tested the numerical accuracy of the answers given to several of the problems with satisfactory results.

(2) Mr. H. B. Dwight is the electrical engineer to the Canadian Westinghouse Company, and is one of the greatest authorities on long-distance power transmission. To the reader conversant with the technicalities of electrical engineering this book can be warmly recommended. The author points out the advantages of using special synchronous motors to keep the voltages at the distributing stations constant under all conditions of load. By this means the radius of action of electric power transmission can be very considerably increased. The main advantage gained by this increase of distance is that it renders possible the linking together of large networks either directly or by suitable "frequency transformers." The economies rendered possible by this procedure are well known and much thought about by electrical engineers. Unfortunately the main difficulties in linking up all the supply companies in London have to do with the vested interests concerned and the inherent conservatism of station engineers.

In America there are several large networks already in existence. In North and South Carolina, for instance, over a thousand miles of 100,000-volt transmission lines are now linked together, the lines stretching across 800 miles of country. The Pacific Gas and Electric Company of California has a network of 1500 miles, part of it being at 60,000 and part at 100,000 volts. It is highly probable that even this extended supply of "electricity in bulk" will seem quite small in a few years' time, as some of the many schemes projected for linking up systems of electric railways are sure to be carried out. Mr. Dwight's book, therefore, discusses a problem of great commercial and economic value. In discussing the more technical side of the problem Mr. Dwight uses complex hyperbolic operators, and has been successful in considerably simplifying the usual treatment.

(3) Mr. W. Perren Maycock's book is intended as an introduction to alternating-current work. The diagrams are beautifully clear, the apparatus described is all useful and fundamental, and the descriptions are good. Simplified vector diagrams are given. Many will find this work useful as an introduction to more advanced treatises.

The defects of the book are due mainly to an attempt to explain to the non-mathematical reader certain steps in the proofs of physical theorems which demand mathematical knowledge. Unless these steps are proved rigorously it does not seem worth while to give them. No proof, for instance, is given that when the voltage follows the harmonic law its effective value equals 1·11 times its average value. To assume this, and to point out in reasoning backwards that

$$1{\cdot}11 = 0{\cdot}707/0{\cdot}636 = \pi/(2\sqrt{2}),$$

is rather a futile proceeding. It would be better to state definitely that the value 1·11 used by the designer of alternating-current apparatus is approximately equal to $\pi/(2\sqrt{2})$, which is the value deduced theoretically from the properties of the sine curve.

(4) From the point of view of the teacher, the chief merit of Mr. Finn's book is its thoroughly practical nature. Assuming that the physical laboratory is fitted with the electric light, he shows that many excellent and instructive experiments can easily be arranged for junior students. The student will appreciate the notes on heat and dynamics which are freely interpolated throughout the text. The introduction and explanation of technical terms in common use are innovations which are to be commended. Everyone should know what is meant by an adapter, a wall-plug, a kilowatt-hour, bayonet and screw cap lampholders, etc. We think also that all teachers should know what is meant by "earthing," and that one of the mains of the supply company is usually earthed. Electrical students have generally very hazy notions about what is meant by the potentials of the supply mains. They seem to have acquired at school the notion that difference of potential is the only thing that need be considered, and that the absolute value of the potential is of no consequence. A good teacher could easily explain the fallacy of this by pointing out how workmen sometimes get dangerous shocks owing to neglect of certain very elementary precautions.

In one or two places the author's experiments are perhaps too elementary. For example, it seems unnecessary to prove that the currents in conductors in parallel are not always equal to one another. In some places the wording is clumsy. On p. 374, for instance, instead of saying "the bigger is the dielectric strength said to be," it would be better to say "the greater the electric strength." We are told that the "dielectric constant" of a medium "varies somewhat with the length of time for which the E.M.F. is applied." Whether this is true or not depends on how we define the dielectric constant. It certainly varies with temperature. Everyone must perforce admit that it is not a constant. It seems foolish, therefore, for physicists to go on calling it a constant. The terms inductivity, dielectric coefficient, and S.I.C. are in use. There is no excuse therefore, for using the word "constant" for a variable quantity.

After defining the electrostatic unit of potential,

the author goes on to say that "it follows" that the electrostatic unit $= 3 \times 10^{10}$ A.E.M.U.'s of E.M.F. $= 300$ volts. It would be a phenomenal beginner who was able to follow this reasoning without further explanation. A. RUSSELL.

OUR BOOKSHELF.

Overcrowding and Defective Housing in the Rural Districts. By Dr. H. B. Bashore. Pp. 92. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1915.) Price 4s. 6d. net.

WE are apt to associate overcrowding and defective housing with towns in the "old" countries, but it is well to realise that a condition of things as bad or worse may exist in our rural districts and in new settlements. In this little book Dr. Harvey Bashore, an inspector in the Pennsylvania Department of Health, describes conditions of overcrowding and defective housing which exist in his own district. He deals with the subject under four headings: (1) land overcrowding; (2) house overcrowding; (3) defective buildings; and (4) overcrowded and defective schools.

Instances of these various conditions, illustrated by well-reproduced plates, are given, and the results are summarised in a concluding chapter. The latter are exactly the same as in the great cities—lack of efficiency, disease, and premature disease to many—"while the great majority of people subjected to overcrowding and bad housing do not prematurely die, yet they have a lessened physical and mental vigour and are less able to do properly their daily work, and not only become a loss to themselves and their families, but to the State; and for ever stand on the threshold of that dread disease—tuberculosis; for tuberculosis is the one great disease of the overcrowded." As regards the remedy, Dr. Bashore says: "This problem cannot be attacked, as in the great cities, by legislative enactment or resort to legal measures, but the solution lies in proper education by the health authorities, by the schools, and by the Press, and the crusade must be kept up until the people understand that it pays—pays in real dollars and cents—to live in sanitary homes."

Although written from the American view-point, we would commend this little book to the notice of councillors, landlords, and health visitors in this country. R. T. HEWLETT.

Typical Flies. A Photographic Atlas of Diptera, including Aphaniptera. By E. K. Pearce. Pp. xii+47. (Cambridge: At the University Press, 1915.) Price 5s. net.

THIS volume contains four pages of introduction, with instructions for collecting and for setting specimens of flies caught, Brauer's Classification of Diptera (four pages), and 155 reproductions in half-tone of photographs of fleas and flies. Its aim is to be of service to the beginner and to draw attention to the interest of an order of insect that is much neglected.

The photographs are as good as any we have seen of this class of insect—a peculiarly difficult class to represent pictorially in any natural manner; the venation of the wings is well brought out wherever the banding or colouring of the wings does not obscure it, and there are excellent short notes as to habitat, larval habits, and so on under the pictures. We wish it had been possible to provide under the photographs line drawings of the more important types of venation and of some of the antennæ; but the interest taken in this group is so little that we imagine further expenditure on the volume was impossible.

The diversity of appearance is well brought out; to the student the venation systems depicted will be helpful, and to the beginner the variety of habitat and habit will be distinctly stimulating.

Probably no order of insect will so well repay the collector and investigator in this country, and we hope this volume may stimulate a wider interest in this fascinating group. H. M.-L.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Destruction of Wasps.

YOU may be interested to know that whilst starting up a motor-cycle a few days since, I accidentally discovered that benzol sprayed over a wasp instantly killed it. I tried the same experiment with petrol with the same result.

Knowing of two nests in the neighbourhood I went that night and with a small oil gun injected two or three ounces of benzol into each nest. In the morning I found the two nests entirely destroyed.

Next night I visited an open nest which had been partly destroyed by another means, and in which several hundred wasps were still living. They covered an area as large as a cheese plate, and on lighting them up showed signs of activity. One squirt full of petrol was hastily sprayed over them, and the whole lot were instantly killed.

This method is so safe, simple, and effective that I feel it should be generally known. The petrol or benzol acts entirely by vaporisation and produces asphyxiation. It is not fired in any way.

A. H. MITCHELL.

Horn's Green, Knockholt, Kent, August 24.

Atlantic Oceanic Currents.

A LARGE bell-buoy was cast ashore at Porto Santo, the northern island of the Madeira group, in the early days of March in the present year.

I have ascertained that the buoy came from Pearl Reef, Magdalen Islands, in the Gulf of St. Lawrence, having broken adrift from its moorings in the autumn of 1912, occupying thus two years and a half in transit. These facts are important at a time when our accepted notions of the strength and direction of the Atlantic currents are undergoing revision.

It may be remembered that Christopher Columbus, who resided at Porto Santo, and married a daughter of Peristrello, the Governor in those days, derived his inspiration and dream of lands beyond the sunset from the arrival of seed-pods and other suggestive matter drifting in upon the broad current which bathes these rocky shores. MICHAEL C. GRABHAM.

Madeira, August 19.

THE BRITISH ASSOCIATION MEETING IN MANCHESTER.

THE meeting of the British Association in Manchester will provide a busy week for those who choose to avail themselves of the opportunities provided for scientific discussion and visits to places of special interest. As previously announced, the long-distance excursions that old members are accustomed to on the afternoon of the Saturday and on the last Wednesday of the meeting will not be found on the programme, but the executive committee has arranged for a large number of visits to the principal municipal undertakings, works, and warehouses, which should prove to be of exceptional interest. Most of these visits will be made in the afternoon, and will not therefore interfere with the important work of the sections. It is difficult to select from the list any one that may be regarded as especially noteworthy because there is so much variety offered by the great industrial community of which Manchester is the centre, and an appeal to many different interests will be made. But as the Manchester Ship Canal is sometimes regarded as one of the wonders of the world, it is probable that the visit to the Manchester docks and canal will be one of the most attractive features. This visit will take place on the afternoon of Friday, September 10, and the party will be limited to one hundred. The Ship Canal Company has kindly provided a special steamer for the visitors, and arrangements will be made for the inspection of all the principal engineering features of this great undertaking.

The important works of the Manchester and of the Salford electricity departments will be shown to small parties in the course of the three working days of the meeting, and opportunities will be afforded for members and associates to visit the corporation gas works, water works, and sewage disposal works. Of the visits to the works of the principal Manchester industries that to the Pilkington Tile and Pottery Co. at Clifton Junction will probably be one of the most interesting; but the most ambitious so far as distance is concerned is the proposed visit to the soap works of Messrs. Lever Bros. at Port Sunlight on Thursday, September 9.

Other visits that may be specially referred to are to the works of the cotton spinners, of several large electrical machinery manufacturing companies, of the great Manchester warehouses, of the hat manufacturers of Stockport, of the calico-printers, of the packing warehouses, etc.

In connection with the special work of the sections several excursions on a small scale have been arranged. Thus, Section C (Geology) will adjourn in the afternoons for visits to places of geological interest in the immediate neighbourhood for field demonstrations of Dr. Hickling's paper on the geology of Manchester, and there will be a longer excursion arranged for the Saturday afternoon. Section D (Zoology) will adjourn to the zoological laboratories on Thursday afternoon for exhibits and demonstrations of original work that has been conducted or is in progress in the university. Section E (Geography) proposes an afternoon excursion into Derbyshire. Section H (Anthropology) proposes a visit to the Roman camp at Ribchester, on which occasion Sir F. F. Adam will preside. For Section K (Botany) a series of interesting demonstrations in the botanical laboratories of the university are being arranged; and Section L (Educational Science) has arranged for two visits to educational institutions, one, on Thursday afternoon, to the Kindergarten Training College in Whalley Range, when Sir William Mather will entertain the party to tea, and the other to the school for feeble-minded children at Sandlebridge.

On Wednesday evening the Lord Mayor of Manchester will hold a reception in the Manchester School of Technology from 8 to 8.30, after which members and associates will be able to inspect the workrooms, machinery, and appliances of the institution.

Every effort is being made by the local executive committee to ensure the success of the meeting, and although it cannot be expected that the numbers will be as large as they would have been in normal times, there is every prospect of a good attendance of men of science and of important work being done.

ART AND CRAFT IN FISHING.[1]

IN recent years the contemplative man seems to have changed his nature, to judge from some of the books which he gives to the world. Time was when he was content just to go fishing, with the simple object of catching fish. But now his demeanour is more that of a man who is setting out on a serious piece of scientific work, and, though he has not quite lost what Francis Francis used to call "a kind of prejudice for a brace of fish in the creel," he is mighty particular as to how that brace of fish got there. Should he, so to say, have been overtaken in inadvertency and have decoyed one of them in a manner not permitted to the elect, his conscience will know many pangs, and likely his tongue will begin the story with apology and end with explanation. There is no longer pride in a fish just as a fish. The modern achievement is a fish caught on a female olive. The same fish caught on an Alexandra would be like a shot fox; for the angler has become a much improved and superior person, and (may we confess it?) at times a little difficult to live with.

His literature, however, has certainly gained in interest, because it can no longer be said, as it used to be said, that there is nothing new to be written about fishing. The mere discovery of the female olive brought a whole new world swimming into one's ken. And since then there have been

[1] (1) "Fly-Fishing: Some New Arts and Mysteries." By J. C. Mottram. Pp. xii+272. (London: *Field* and *Queen* (Horace Cox), Ltd., n.d.) Price 5s. net.

(2) "The Complete Science of Fly Fishing and Spinning." By Fred. G. Shaw. Pp. xiii+432. (Published by the Author, Neville Court, Abbey Road, N.W., 1914.) Price 21s.

other developments to give the angler a still more earnest countenance, such as the discovery that a fish's life-history is written on its scales, or that you may capture a chalk-stream trout with a wet fly, not as of old empirically, but with due regard to all the laws of science, and in a manner to command the admiration of the impartial.

(1) Dr. Mottram's little book is an excellent sample of the newer fishing writing, in which various old problems are approached in the spirit of scientific inquiry, solutions being offered in a way that inspires confidence. The author is evidently a good and very zealous angler, he has had a scientific training, and he does both experimenting and thinking for himself. He seems singularly free from the common angling tendency to take other people's experience for ascertained fact, which gives his conclusions, even in matters on which others have written with authority, a value of their own. He treats of a great diversity of subjects, of water weeds and their merits as food-producers (here, though generally sound and useful, he is too sweeping; for instance, he condemns *Elodra canadensis* out of hand, which seems strange; it is horribly free in its growth, but it is far from being a bad weed otherwise); of the colour sense of fish, citing a very interesting and careful experiment, which showed a roach to have a sense of colour; of optical problems. which are about the latest of the fly-fisher's studies, adding something to our ideas; of waterside fly-tying, the treatment of mud, fish watching, difficult casts, and so on. He gives several chapters on his own sport, especially in New Zealand, where he seems to have been about the first angler to study natural flies and imitate them.

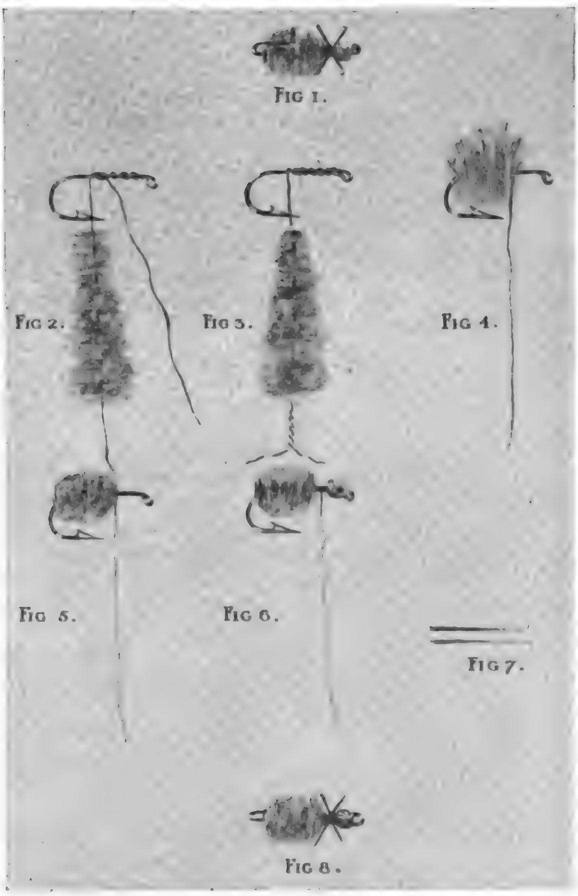

FIG. 1.—The tying of a new fancy fly. From "Fly-Fishing: Some New Arts and Mysteries," by J. C. Mottram.

This brings us to what is certainly the most important part of Dr. Mottram's book, his theory of imitation of flies, which is unfolded in a chapter entitled "Flies of the Future." He breaks boldly away from the exact imitation school with its tradition of stiff opaque wings for floating duns, and substitutes what might be called a policy of impressionism, in which he lays special stress on the shape of a fly's body and on methods of obtaining the transparent effect which is so defiant of imitation in the natural dun. The idea that "one of the best ways of indicating transparency is to omit the transparent parts altogether," is extremely ingenious, and it should work out well in practice. Ingenuity is, indeed, a marked feature of the whole book, which is a valuable addition to the fishing library.

(2) Mr. Shaw's book is a more ambitious volume, as its rather formidable title would indicate. The "complete science"—it is a big aim. In one respect, however, Mr. Shaw seems to us to justify his selection of the title. There is probably no angler of the day who has so carefully studied what may be called the dynamics of fishing, the various ways of getting a fly or spinning bait to a given point in the most effective manner. Mr. Shaw's chapters on casting show a remarkable grasp of principles, the exposition of which will teach even the oldest hands a lot. Most anglers—even very good—cast their fly or bait without any very clear notion how they get the results they aim at. They know these to be fairly satisfactory and do not trouble further. Mr. Shaw shows exactly what happens when you do certain things with your rod, and proves conclusively why it must happen. Also he suggests many other things which you may do, things of which you have very likely never thought, and which are bound to be extremely useful to you. Wind casts, Wye casts, steeple casts, Galway casts, loop, switch, and Spey casts—there are many devices by which you can get the better of difficulties. With excellent photographs and diagrams Mr. Shaw expounds them all, and if it is possible for a man to learn technique from the printed page—and it certainly is possible for some—he should gain a great deal from this book.

In the other portion of the volume he deals partly with the practice of fishing and partly with various matters, more or less scientific, in which the angler takes an interest. He is obviously a good fisherman as well as a good caster (the two are not necessarily complements of each other), and he is full of useful hints and contrivances such as an expert picks up in many years of fishing.

For instance: "Use the two tops of your fly-rod alternately," he advises, and the advice is very obviously sound. But some of us, alas! have never thought of it before, regarding the second top as merely a spare one for emergencies. And yet we have talked to each other with conviction about split cane getting "tired" after continuous use for some time! This is a small matter, but there are plenty of similar casual hints which will come forcibly home to a good many of us who have long passed out of our novitiate.

In the other chapters Mr. Shaw deals with the fisherman's entomology, now a fairly well-ploughed field, with pisciculture and the natural history of trout, of which much the same may be said, now that there is a trout farm in almost every likely valley of springs, with the senses of trout, particular attention being paid to their vision, and especially to how far they can see behind them, a point which so far as we remember

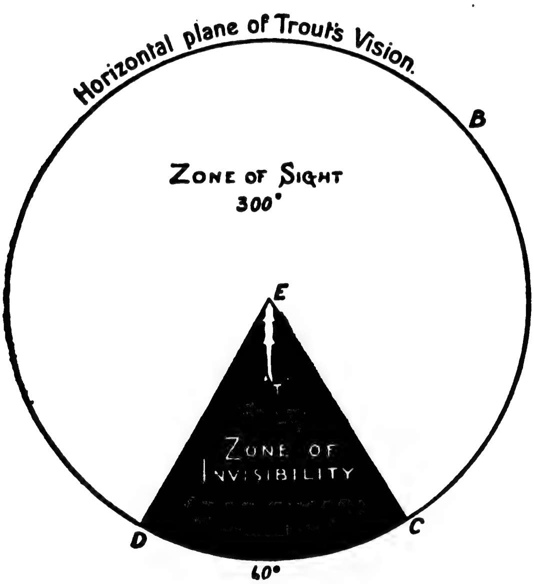

FIG. 2.—From "The Complete Science of Fly Fishing and Spinning," by F. G. Shaw.

no other writer has tackled—but it is one of importance, as every man who has stalked a fish on a "shy" day will allow.

There are also chapters on salmon and salmon scales. In the last Mr. Shaw devotes a great many words to labouring what seems to us an odd objection to the usual interpretation of what is called the spawning mark, which is, of course, that a fish has spawned in some previous year. Mr. Shaw apparently wants evidence of the act itself before he will admit that salmon ever spawn more than once. The spawning mark, in his view, would, we gather, be evidence of a visit to fresh water for the purpose of spawning, but not necessarily that the purpose was satisfactorily accomplished, the ova being duly fertilised and safely stored in the redds. So far nobody would quarrel with him, we expect, but, unless we wrong him, he seems to find in the spawning mark evidence that the spawning purpose has *not* been carried out, the eggs being voided in vain or re-absorbed. A fish so cheated "will return again and again until it has satisfactorily achieved its life's purpose." We fear we cannot produce scales from a fish marked in the act of spawning and recaptured later, to convince Mr. Shaw. Perhaps he can produce scales from the necessary percentage of unfortunate fish which have been found voiding their ova in vain to convince us? At present our inclination is towards the current view of the spawning mark and its significance. There are other points in the book in which our view would not coincide with Mr. Shaw's (incidentally we have found some scarcely excusable misprints), but on the whole we must own to having studied him not without pleasure and profit.

THE TESTING OF CHRONOMETERS.[1]

IN his recently issued report on the testing of chronometers at Geneva, M. Raoul Gautier, who has been in charge of the department for twenty-five years, takes the opportunity of reviewing briefly the successive alterations and improvements that have been introduced in the methods of testing, and the happy results that have followed from the maintenance of a high standard. We may take this same opportunity of congratulating the distinguished director of the observatory on the useful work accomplished, and with which the name of Gautier has been so long and so honourably connected.

Nearly a century has passed since Alfred Gautier combined the duties of the director of the observatory with those attached to the Chair of Astronomy. But even before that time Geneva was bidding for the watch trade and fully alive to the advantage that would accrue from an increase in the accuracy of performance. In 1789 prizes were offered by the local Society of Arts for a notable improvement in the rate of pocket watches, but the prize remained unawarded, for the ambitions of the judges were so much in advance of the abilities of the maker that the standard was not attained. In framing more modest requirements, it was stipulated that the daily rate of the watch should not vary more than one minute during a trial of a month in a vertical and horizontal position, and not more than two minutes when worn for the same period. Two watches were submitted, and one was stated to have fulfilled the conditions.

These were humble beginnings, and the disturbed state of Europe during the Napoleonic wars prevented anything like an annual competition, which the local Society of Arts proposed to hold. But progress must have been rapid, for in 1816 the limit of variation of rate was reduced to three seconds in twenty-four hours, whether the watch was at rest or carried in the pocket. For the first time we find a temperature factor mentioned: the watch was to be kept in a constant temperature of 25° Réaumur, and it was not till much later that any serious attempt was made to remove the ill

[1] "Rapport sur le Concours de Réglage de Chronomètres." Par M. le Prof. Raoul Gautier, Directeur de l'Observatoire de Genève.

effects of varying temperature on the rate of pocket watches.

The main fact to be noticed in connection with these early trials is that they settled the lines on which future tests have been made. The qualities demanded now are, as they were then, smallness of daily rate, uniformity of rate in different positions of the balance, and constant rate within a considerable range of temperature. The number of variables is small, and wherever chronometer testing is carried on, little change has been made in the manner of conducting the test. Details vary at different observatories, but one general practice is pursued. For a certain number of days constituting "a period," the watch is kept in a vertical position with pendent up, or to the right, or left, and horizontally, with dial up or down. Further the watch is submitted to varying temperature, generally covering about 50° F. in the whole, and throughout the several "periods" the daily rate is determined by comparison with a clock regulated to Greenwich Mean Time. The relative excellence of the instrument tested in shown by assigning marks for its performance in each period, and herein there is room for the exercise of individual judgment in deciding relative merit. One authority may consider the elimination of temperature effects of more importance than smallness of rate, and give higher marks accordingly. To secure accurate adjustment for "positions" may seem to some the most desirable qualification.

M. Gautier hints that steps might be taken with advantage to secure greater uniformity among different observatories. But the system of awarding marks is of no great importance, for a good watch comes so near perfection that it will take nearly the maximum of marks, however they are divided. M. Gautier remarks that a comparison between the trials at Kew and Geneva shows that the results are in close agreement, and that this conclusion is warranted is proved by the fact that the best watch at Geneva, tested by the Kew system of marks, would have 95·9, while the best at Kew was assigned 96·1 marks.

At Geneva, to within the last few years, the total number of marks that could be earned was 300, of which 100 were assigned to steadiness of daily rate (m); 100 to uniformity of rate in different positions (p); 70 for excellence of temperature compensation (c); and 30 for smallness of variation (r) throughout the test. At the same time limiting values are assigned to m, p, c, and r, which may not be exceeded without loss of certificate. These several maximum values are shown in the expression from which is computed the number of marks to which the watch is entitled.

$$N = (0^{s}{\cdot}75 - m)\,400/3 + (2^{s}{\cdot}50 - p)\,40 + (0^{s}{\cdot}20 - c)\,350 + (5^{s}{\cdot}00 - r)\,6.$$

If any one of these terms is negative the watch fails to meet the test, but it can be withdrawn, corrected by the maker, and re-submitted to test in those particulars in which it failed, but the opportunity of competing for the highest places in competitive tests is denied to such watches. Later, the number of marks was increased to 1000, but the two scales are not directly comparable, for the conditions of test have been made more severe. The variation from daily rate must not exceed 0·5 sec. in any one test, the rate in different positions is reduced from 2·5 sec. to 2·0 sec., and in other respects the demand for greater accuracy is on the same scale.

It is gratifying to know that the improvement in manufacture has more than kept pace with the requirements for test, and that M. Gautier is able to report that the highest excellence yet attained was exhibited by the chronometers of 1914. This also is the experience of Kew, where of sixty-two watches submitted to trial, forty-eight were awarded more than 90 per cent. of the maximum marks. Of even greater significance is the increasing certainty of manufacture. The writer of this article has long held that after a certain high standard has been reached, the maker must depend upon some lucky accident for pre-eminence. He is unable to explain the cause of superiority, and though he may take equal care he cannot repeat his success. But when we find that the Kew record is held by M. P. Ditisheim, of Chaux-de-Fonds, with a score of 96·1, and the same maker is able to secure the first four places in a competition of unusual severity, it is evident that chance is fast being eliminated. Such improved workmanship demonstrates the success that has attended the scheme of annual competition, originated with the view of encouraging the Swiss watch manufacture. The number of watches submitted for test is not large, about 200 per annum, but a healthy competition has raised a high standard of excellence, and taught the public what to expect.

Besançon leads the way in France. The method of test varies slightly from that of Geneva, but the details only concern the expert. The point we would make is that such establishments are eminently useful and instructive. By advertising widely what has been accomplished they make the public dissatisfied with inferior workmanship, and they offer opportunities for the careful maker to gain recognition for his work. A standard of accuracy is set up that encourages the public distribution of time signals, and promotes a smoother working of national life.

FREDERICK MANSON BAILEY, C.M.G.

THE death of Frederick Manson Bailey, C.M.G., the veteran Colonial Botanist of Queensland, which was announced in the last issue of NATURE, will be felt as a great loss to Australian botany. He inherited his botanical tastes from his father, John Bailey, who emigrated to South Australia in 1838, the family having conducted the business of nurserymen and seedsmen in London for many years. F. M. Bailey helped his father for a time in the nursery business at Adelaide, which he established on resigning the position of Government botanist—to which post he was appointed on his arrival in South Aus-

tralia—but he did not seriously take up horticulture again until he landed at Brisbane in 1861 after a spell of gold-digging in Victoria and farming in New Zealand. He then established a seed business in Brisbane, a venture, however, attended with no great measure of success owing to financial conditions in Queensland, but his real opportunity came in 1875, when the Queensland Government appointed a committee to inquire into diseases affecting live stock and plants, and he was chosen to investigate the botanical problems involved. In connection with the duties of this appointment he travelled far and wide throughout the State, and gained that extensive knowledge of the flora of Queensland which enabled him to make his numerous and valuable contributions to Queensland botany.

His earlier work was mainly connected with the native grasses of Queensland, which formed the subject of many articles valuable to the botanist and agriculturist alike. He was next appointed to the charge of the botanical section of the Queensland Museum, and in 1881 was made Colonial Botanist, the post which he held until his death. The duties of this post, which were very congenial to him, he discharged with conspicuous ability and untiring devotion, and, during the times of depression when the post was abolished, he continued his work unpaid until, as a result of general protest, he was reinstated in his former position.

The distinction of C.M.G. conferred upon him in 1911 was a fitting recognition of the value of his botanical and agricultural services to Queensland. His contributions to botany embrace the purely systematic as well as the economic aspects of the subject. Another subject to which he paid particular attention was the medicinal uses of plants.

Among his more important publications must be mentioned "The Flora of Queensland" in seven volumes; "The Handbook of the Ferns of Queensland"; a sketch of the "Economic Plants of Queensland"; "Plants reputed Poisonous and Injurious to Stock"; "Queensland Woods"; "Queensland Grasses," etc.

Bailey also devoted much time and attention, especially in later years, to the study of fungi and algæ, and until a few days before his death he was a regular contributor of critical specimens to the National Herbarium at Kew, which has been greatly enriched, as regards the Queensland flora, by the specimens he so generously presented.

NOTES.

WE see from the Transactions of the Royal Scottish Arboricultural Society (of which he is the honorary editor) that Dr. A. W. Borthwick, lecturer in forest botany in the University of Edinburgh, has been appointed by the Board of Agriculture for Scotland to be the advisory officer of the Board for forestry in succession to the late Dr. John Nisbet.

WE learn that the nineteenth International Congress of Americanists, which was to have been held in Washington in October next, and which was postponed in consequence of the war, is, according to present arrangements, to take place at Washington on December 27–31 next, in conjunction with the anthropological section of the Pan-American Scientific Congress, the American Anthropological Association, the American Historical Association, the American Folklore Society, and the Archæological Institute of America.

THE autumn meeting of the Iron and Steel Institute will be held at the Institution of Civil Engineers on September 23 and 24, when the following papers may be expected to be read and discussed:—Influence of oxygen on some properties of pure iron, W. Austin; note on the carburisation of iron at low temperatures in blast-furnace gases, T. H. Byrom; influence of heat-treatment on the specific resistance and chemical constitution of carbon steels, Prof. E. D. Campbell; effect of chromium and tungsten upon the hardening and tempering of high-speed tool-steel, Prof. C. A. Edwards and H. Kikkawa; phosphorus in iron and steel, Dr. W. H. Hatfield; the magnetic transformation of cementite, Prof. K. Honda and H. Takagi; sulphur in malleable cast-iron, R. H. Smith; iron and nitrogen, Prof. N. Tschischewski.

THE council of the Iron and Steel Institute gives notice that at the forthcoming meeting of the institute the following new rule for addition to the existing by-laws will be submitted:—"In the event of a state of war existing between Great Britain and any other country, or State, all members, honorary members, and honorary vice-presidents who shall be subjects of such enemy country, or State, shall forthwith cease to be members, honorary members, or honorary vice-presidents of the institute, but they may, if the council thinks fit, be reinstated after the termination of the war."

THE Royal Aero Club announces that the British height record for pilot alone has been granted to Mr. H. G. Hawker, the National Physical Laboratory having reported that the barograph and chart used by the aviator on June 6 showed that the height attained was 18,393 ft. The previous best record was that of 14,920 ft., accomplished by Eng.-Lieut. E. F. Briggs, now a prisoner in Germany.

WE deeply regret to record the death in action at the Dardanelles, on August 10, of Second Lieut. H. G. J. Moseley, Trinity College, Oxford, son of the late Prof. H. N. Moseley. Lieut. Moseley was formerly lecturer and demonstrator in physics at the University of Manchester, and holder of the John Harling fellowship for research.

WE much regret to learn that Capt. T. P. Black, 9th Sherwood Foresters, registrar of University College, Nottingham, was killed at the Dardanelles between August 7 and 11. He was for a time assistant in physics at the Durham College of Science, Newcastle-upon-Tyne, removing in 1907 to University College, Nottingham, to fill a similar position. In 1911 he was appointed registrar of the college.

WE note, with regret, the death, on August 28, at the age of fifty-six years, of Mr. Henry Crookes, the eldest son of Sir William Crookes. He was an asso-

ciate of the Royal School of Mines, and a fellow of the Chemical Society.

The death is announced of Lieut.-Col. Edward Lawrie, M.B., I.M.S. (ret.), at the age of sixty-nine. Col. Lawrie was educated at Edinburgh University, and after acting as house surgeon to Prof. Syme, whose views probably largely influenced his subsequent work on chloroform anæsthesia, he entered the Indian Medical Service, from which he retired in 1901. During his career he held the posts of resident surgeon of the Medical College Hospital, Calcutta, acting for some time as professor of physiology in the Medical College, professor of surgery in the Lahore Medical College, and residency surgeon at Hyderabad, one of the most important medical appointments in India. He was best known for his views on anæsthesia, being an ardent advocate of the claims of cholorform to be the best and safest anæsthetic for general use. Lawrie held, with his old teacher Syme, that chloroform killed only through the respiration, and not through the heart. As many held the converse opinion, Lawrie prevailed upon the Nizam of Hyderabad to institute and finance a commission to investigate the subject, of which commission Sir Lauder Brunton was president and Col. Lawrie and the late Sir Gerald Bomford were members. Much experimental work was done, which confirmed Lawrie's views, the monkeys dying without exception from failure of respiration, and a valuable report was published; he was also the author of "Chloroform: A Manual for Students and Practitioners" (1901). When the hospitals for the Indian troops were opened at Brighton in December last, Lawrie was appointed anæsthetist, and carried out his duties until the beginning of his fatal illness last May.

Lieut. Ernest Magowan Harper, 7th Batt. Munster Fusiliers, who was killed in action on August 9, at the Dardanelles, was a graduate of Queen's University, Belfast. He was educated at the Royal School, Dungannon, where he gained a reputation for brilliant work, and received his training as a keen sportsman, which afterwards characterised him at the University. On matriculation he entered Queen's with a junior science scholarship, which he held throughout his undergraduate course. In 1913 he graduated bachelor of science with first-class honours in chemistry, and afterwards was appointed to the Andrews research studentship, which he held until the time of his death. During his tenure of this scholarship he conducted extended researches on the connection between the absorption spectra and the constitution of organic nitro-compounds, publishing two papers in the Journal of the Chemical Society. On the declaration of war he applied for a commission and was gazetted last September, being posted to the 7th Munster Fusiliers. He relinquished his post of senior assistant in chemistry in the University, abandoned his scientific career, and gave himself up unselfishly for his country's cause. In his death the country has lost an able officer, and science a most promising young man.

Lieut. Wolfred Reeve Cloutman, R.E., who was killed in action in France on August 21, was an associate of the Royal School of Mines, obtaining his associateship in mining (first class) in 1912, after winning many prizes and completing a most distinguished career at the school, where his death is felt as a serious loss. Mr. Cloutman's work at the Royal School of Mines (an integral part of the Imperial College of Science and Technology) was further recognised by the award to him of the diploma of membership of the Imperial College. On leaving the school Mr. Cloutman was awarded a scholarship by the council of the Institution of Mining and Metallurgy for a post-graduate course in mines or works in various parts of the world. In 1914 the governors of the Imperial College awarded to him the Warrington Smyth prize and medal for a report which he submitted on certain mining operations in Western Australia. As a mining engineer Mr. Cloutman was valuable to the Army, and in June last he was mentioned in despatches for his skill and success in mining operations.

The death is announced, at the age of forty-nine years, of Dr. R. W. Johnstone, a medical inspector of the Local Government Board. Dr. Johnstone had been British delegate at the International Health Office, Paris, a member of the Commission for the Investigation of Mediterranean Fever, chief technical delegate for Great Britain at the International Sanitary Conference at Paris, 1911–12, and plenipotentiary to sign the International Sanitary Convention of Paris in 1912.

The death is reported, in his sixty-fourth year, of Dr. Thomas Bliss Stillman, an American chemist, who had spent the greater part of his career on the staff of the Stevens Institute of Technology, New Jersey. From 1886 to 1903 he was professor of analytical chemistry in that institution, and from 1903 to 1909 professor of engineering chemistry. He was the author of "Engineering Chemistry," first published in 1897, and of various monographs in American and European scientific journals.

Many of our readers, especially among those who attended the meeting of the British Association at Winnipeg in 1909, will be grieved to hear of the death of Mrs. W. H. Thompson, who has recently succumbed to an attack of appendicitis. Mrs. Thompson was an active member of the committee responsible for the arrangements of the Winnipeg meeting. She was for some years a contributor to the work of the Ductless Glands Committee, and published an important paper on the thyroid gland (Phil. Trans., 1910), in addition to contributions to the Trans. of the Royal Society of Canada and other journals. For some years Mrs. Thompson was librarian of the University of Manitoba, and her loss will be keenly felt in academic circles in Canada.

Mr. Bernard Kettle, curator of the Guildhall Museum, reports some interesting finds of Roman pottery from dust-heaps in the City of London. A large series of these was disclosed when the old General Post Office in St. Martin's-le-Grand was demolished. A few whole pots and many fragments of Samian ware were found here, besides building

materials, whetstones, beads, knives, coins, and other small objects. Most of these rubbish-pits date between A.D. 50 and 200, and by comparison of datable with undatable specimens much light has been thrown upon the seriation of types. From another rubbish-pit in King William Street nine Samian vessels of the first century have been reconstructed, one of them being a vessel finer than any hitherto found in London, and two specimens of a type hitherto unknown in England. These were associated with a lamp, two coins, and other pottery and bronze objects.

THE novel discovery in the Fayum of a nephrite celt is announced by Mr. Oric Bates in the September issue of *Man*. This specimen is remarkable because its greatest width is not, as in the common Fayum type, along the cord of the cutting edge. The material is a sort of nephrite, composed of minute fibres of actinolite, and in its present form it is of metamorphic origin. The source whence the stone may have been obtained is at present uncertain, and it is impossible to say whether this development of actinolite is due to regional metamorphism or contact metamorphism. At any rate, the rock can only have come from some region where there has been extensive metamorphism of one kind or another.

AN important monograph on the genus Sansevieria, the source of bow-string hemp, occupies seventy-six pages of the current number of the *Kew Bulletin* (No. 5). The account is by Mr. N. E. Brown, who has made a lifelong study of this difficult and highly important economic group of plants. The paper is illustrated by a series of text figures representing the salient features of the different species, and there are two plates of a new species, *S. Dawei*, from Uganda. Fifty-four species in all are described in detail, and a full key is provided which should be of great value in running down the plants. In order that the paper may be of use to the planting community, in whose interests it has largely been prepared, the few technical terms employed are fully explained at the beginning. Africa is the true home of the genus, and East Africa in particular, where it is an important economic product. Only four species are known to occur outside Africa, and they are found in Ceylon, India, Burma, and possibly China. Of the fifty African species only five are natives of South Africa, the rest being confined to the tropical area of the Continent. As considerable doubt still exists as to which species yields the best fibre, it is hoped that the publication of the monograph may help to bring about a solution of so important a question.

BOTANICAL specimens are commonly deprived of all beauty, and much of their value, by the loss of colour in the flower-heads. This very serious drawback has now been removed by the timely discovery of a method of colour-preservation by Dr. C. F. Fothergill, and described in detail in the *Museums Journal* for July. It has the further merit of extreme simplicity. Briefly, Dr. Fothergill employs sheets of absorbent cotton wool, placed in three layers forming two compartments between two "grids," which are made of a "wire mesh-work of half-inch squares with a heavy encircling band." The necessary pressure is obtained by fastening one or two straps, preferably of webbing, around the grids, and tightening them as required. The flowers to be pressed, having been placed in the grid, are then suspended in front of a fire, or in the sun, when this is sufficiently powerful. The explanation of the success of the method is, that the process of drying is so rapid that the pigment is fixed instead of being slowly decomposed. Fresh carnations can be preserved in about seven hours. Primroses picked fresh off the living plant can be permanently dried to retain a lifelike colour in two hours if the press containing them is placed in the oven.

THE first part of vol. v., section 2, of *Flora Capensis* has now appeared, having been prepared at the Herbarium of the Royal Botanic Gardens, Kew. The families dealt with are the Thymeleaceæ, 181 species in twelve genera; the Peneaceæ, 24 species in five genera; the Geissolomaceæ, with the single monotypic genus Geissoloma; the Loranthaceæ, consisting of 42 species in two genera; and the Santalaceæ. This last family, which contains six genera in South Africa, is completed as far as the 112th species of Thesium in the present part.

PROF. G. S. BOULGER has published in the form of a pamphlet, price one penny, his paper on the History of Kew Gardens, read before the South-Eastern Union of Scientific Societies. The paper, though covering a well-explored field, contains several interesting particulars about the early history of the Royal Gardens. A letter from Gilbert White to Robert Marsham about Stephen Hales, written in 1791, which is reproduced, presents a very vivid picture of that ingenious physiologist's versatility in all forms of experiment. The history is brought down to the present day, and an outline of the functions of Kew is given in conclusion.

AT the last monthly general meeting of the session of the Zoological Society of London, his Grace the Duke of Bedford in the chair, it was announced that two Californian sea-lions had been added to the menagerie of the society, thus partially repairing the loss by disease sustained some time ago. Two tortoises, new to the collection, were received on deposit on July 18. One of these is the blackish tortoise (*Testudo nigrita*) from Indefatigable Island, the other Bauer's tortoise (*T. galapagoensis*) from Charles Island. The receipts in gate-money for July showed a decrease of 724*l.* as compared with July of last year. The receipts for admission at the gates during the present year—to the end of July—showed a decrease of 274*l.* as compared with the corresponding period during the last ten years. Having regard to the times, this falling-off in receipts is less than might have been expected.

THE *National Geographic Magazine* for August should attain a phenomenal sale, if only on account of its illustrations, which include no fewer than eighty coloured figures of American game birds, by Louis Fuertes. Both from the point of view of scientific accuracy and artistic merit these are as near perfec-

tion as is humanly possible. These illustrations accompany an article on American game birds, by Mr. Henry Henshaw, which should be seriously studied by every field naturalist and sportsman in the British Islands; for the author draws a by no means exaggerated picture of the ravages inflicted by modern firearms on birds of real economic importance, and the need for drastic legislation to prevent their speedy extermination. And there can be no question but that his contentions have their roots deep down in solid fact. In a second article, describing the impressive transformation in the physiography of the country affected by the formation of the huge lake in the Gatun region, during the construction of the Panama Canal, Mr. George Shiras draws a vivid picture of the destruction of animal and plant life which has been inevitable but none the less regrettable. Thickly forested valleys teeming with animal life have now been converted into one vast lake. But the author holds that this area should be converted by the Federal Government into a reservation for the absolute protection of the survivors from this deluge. In course of time, he points out, if this is done, water-fowl of all kinds will find sanctuary here, and serve as a "feeder" for the areas depleted by the sportsman.

IN his presidental address, read at the American Association of Museums, San Francisco, Dr. O. C. Farrington gave an able summary of the origin and evolution of natural history museums, which should be widely read in this country. More especially is this to be urged in view of the danger which threatens such institutions in the immediate future in regard to the policy of national retrenchment which is now in process of formation. There is a danger that the pruning-hook may be used too ruthlessly, thereby inflicting material harm. For reformers are generally enthusiasts, and therefore are to be carefully watched, experience having shown that a sense of proportion is not usually among their attributes. Museums, as he remarks, are even now commonly regarded as a luxury, but he leaves no uncertainty as to the vitally important part which the modern museum plays, and must continue to play, in ever-increasing force, in our national life: widening our outlook and conceptions of existence, and affording to the uninitiated sources of information as to the nature of disease and pestilence, and other aspects of economic zoology which are indispensable to the speeding up of progress and well-being.

IN *La Nature* for August 21, 1915, L. De Launay shows the extent of the recent discoveries of coal-bearing strata in Germany, Belgium, and the Netherlands. Though the ultimate ownership of some of these stores may seem uncertain, there is no doubt as to their importance in the economy of Europe. The explorations have proceeded at depths from 1000 to 1500 metres (nearly 5000 ft.). The Westphalian coalfield has thus been connected with that of south-east Belgium, through the tracing of intermediate fields between Wesel and Aachen. On the east side of the Rhine, moreover, from Essen to Wesel and Haltern, the Westphalian basin has been proved to have a vast extension. West of the Meuse, and south of the innocent lands of Nijmegen, Holland participates in the new discoveries. At the Dutch frontier the coal is within 300 metres of the surface. Since 1901, the Belgian field has been traced far northwards beneath the Cainozoic strata of Limbourg between Brussels and Maastricht, and away west into the province of Antwerp. The results in northern France have been less important, but the total coal resources of the areas dealt with in M. De Launay's article are double those that were known a few years ago. The author cannot resist a suggestion that, "after the war," France should annex the basin of the Saar.

DR. A. WADE's researches on "The Supposed Oil-bearing areas of South Australia" have been published as Bulletin No. 4 of the Geological Survey of the State. Its wise conclusions and scientific thoroughness recommend this report as a model to be followed by explorers. The remarks about those superficial observers who stimulate unprofitable enterprises by saying that "the country is exactly like such-and-such an oilfield" should be read by financial magnates as well as by would-be prospectors.

IN the fifth volume of the Journal of the Natural History and Science Society of Western Australia (Perth, 1914, price 2*s*. 6*d*.), C. G. Thorp (p. 20) reviews the interesting glassy bodies known as Australites, and gives a useful map of their distribution. He regards them as ejected from a volcano or volcanoes in the East Indies, some of them in Tertiary and some in modern times. The blebs of glass now found were attached to bubbles, and were thus carried into the currents of the cirrus-cloud level of the atmosphere. The author has succeeded in obtaining artificial glass bubbles with blebs attached; but some accident seems to have prevented their appearance among his illustrations. He believes that some of the surface-glaze in australites results from fusion while falling through our atmosphere. F. Berwerth, it may be remembered (NATURE, vol. lxxxix., p. 513), used the absence of such signs of fusion in moldavites as an argument against the meteoric theory of their origin, and in this he received support from G. P. Merrill's work on australites. E. W. Skeats describes "three unusual forms of australites" from gravels in Western Victoria (Proc. R. Soc. Victoria, vol. xxvii., 1915, p. 362).

IN a review of "The Origin and Formation of the Diamond" (S. African Journ. Sci., vol. xi., 1915, p. 275), W. Johnson combats the theory that the South African diamonds were formed from carbon dissolved in molten kimberlite, and urges that pressure was the primary factor in their production, at a time when the igneous ground was buried in the crust far more deeply than it is at the present day.

THE Bulletin of the American Geographical Society for August, 1915 (vol. xlvii.), illustrates, in a paper by H. E. Gregory, of Yale, the huge buttes left in the Navajo country by erosion of red Permian sandstones. Wind is still the great enemy in this plateau

region, which lies between 4000 and 7000 ft. above the sea. The Colorado River is the only stream that maintains a strong flow throughout the year, and the meteorological records show great variations in rainfall from year to year, but indicate a brief rainy season in July and August. In the same number of the Bulletin, Sidney Powers, of the Hawaiian Volcano Observatory, provides some striking photographs of the lava-lake of Kilauea.

THE mineral and petrographic studies which form a special feature of the American Journal of Science are continued by W. E. Ford (vol. xl., p. 33), who investigates "the relations existing between the chemical, optical, and other physical properties of the members of the Garnet group," and in the following number by N. L. Bowen (*ibid.*, p. 161), who has experimentally investigated the crystallisation of simple types of basaltic and dioritic magmas. Mr. Bowen concludes that the more acid subalkaline igneous magmas are "derived from basic material, being, as it were, successive mother liquors from the crystallization of the basic magmas." Syenite may thus arise as an upper product of differentiation from a large slowly cooled mass of basaltic magma.

THE Canadian Department of Mines has issued recently three memoirs dealing with the coal resources of the Dominion; two are issued by the Geological Survey, namely, "Coal Fields of Manitoba, Saskatchewan, Alberta, and Eastern British Columbia," and "Coal Fields of British Columbia," both by D. B. Dowling, and one is issued by the Mines Branch, namely, "Products and By-Products of Coal," by Messrs. E. Stansfield and F. E. Carter. The two first-named deal more especially with the geology of the coal fields of western Canada, and will be welcomed by all interested in the geology of coal, more particularly because they deal with important coal deposits in relatively recent formations, Cretaceous and Tertiary. The third pamphlet will no doubt appeal to a wider public, its object being to present in a simple and accessible form the various economic applications of coal products, and, in the words of the authors, their "aim has been to give prominence to the commercial rather than to the scientific aspect of the subjects treated." Coke, gas, ammonia, tar, and the derivatives of coal-tar are briefly discussed in turn, and their economic and industrial importance is explained. Under the last head the question of the dye industry is touched upon, and the authors have quoted certain statements of Dr. Bernhard C. Hesse, of New York, which well deserve the widest possible publicity, showing, as they do, a remarkably sane and sound appreciation of the difficulties of the question. He points out that the coal-tar dye industry is not a unit, nor does it even consist of a number of independent units, but "is really a conglomerate of many separate parts acting and reacting upon each other, commercially and industrially"; his final conclusion being "that the whole of this industry cannot be successfully transplanted, and attempts to transplant part only have not resulted in any self-contained and independent industry anywhere."

THE *Monthly Meteorological Charts of the North Atlantic and Indian Oceans* for September, 1915, recently issued by the Meteorological Office, contain much which is of interest to the navigator. There is much else besides the precise detail as to the frequency of wind and current. An inset chart is given on the Atlantic issue showing the distribution of fog and mist over the ocean in September. It is shown that fog is seldom experienced on the steamer tracks in mid-Atlantic during September, and there is never as much as 20 per cent. in that month anywhere over the North Atlantic, as against 30 per cent. near Cape Race in August, and 40 per cent. in July. The Atlantic chart also contains on its reverse charts of the mean salinity and surface temperature of the North Atlantic and of the English Channel. The chart for the Indian Ocean gives graphically details of the ice in the southern hemisphere, also detailed information relative to the results of meteorological observations in the Persian Gulf and the Gulf of Oman.

ACCORDING to an article in the *Scientific American* for August 14, Dr. F. C. Brown, of the physics department of the State University of Iowa, has applied his discovery of the great sensitiveness to light of a selenium crystal as compared with the ordinary selenium film to the production of a "phonopticon" to enable blind persons to read printed matter. The instrument is a simplification and improvement of Dr. Fournier's "type-reading optophone." A box carrying a lamp, and provided with lenses, is moved along the line of print. By this means a short vertical bar of light moves along the line from left to right, and an image of the bar is cast on two or more selenium crystals in such a way that each crystal is covered by a fixed part of the line. Each crystal forms one side of a resistance bridge, which is balanced when the bar of light falls on white paper. Want of balance when the bar covers a portion of a printed letter is detected by a telephone in series with a rotating contact-maker. Each bridge has a contact-maker of a different period, and on listening to the joint effect of the telephones it has been found possible with not more than two telephones to recognise the sequence of sound for each letter of the alphabet.

WHILE the teaching of the calculus is now taken at an early stage in our curricula, the results do not appear to have been altogether satisfactory in America any more than here. We have recently received reprints of a discussion on "Practical Mathematics" opened by Prof. W. S. Franklin and his assistants before the Society for the Promotion of Engineering Education (Bulletin iv., 10, p. 5; Proceedings, xxii., p. 149), and we also have before us Prof. E. B. Wilson's reviews of recent text-books in the Bulletin of the American Mathematical Society for last June (xxi., 9). The failure of the students to profit by the course would appear to be due to the want of rigorous logical reasoning, to the failure to illustrate the subject by concrete physical and other illustrations, and to "the entire absence of suggestiveness in his mathematical studies and the inhibition of sense by the excessive formalities of ordinary

mathematics instruction." Prof. Franklin also raises certain objections to the syllabus definition of differentials, but we are sorry to see that he himself perpetuates the worst defects of our text-books by expanding series of powers of differentials. It is, of course, possible to expand $f(x+dx)-f(x)$ in powers of dx, and when the result is divided by dx the limit of the series does happen to be *equal* to the differential coefficient in most cases, but the differential coefficient cannot be *defined* as the limit of the series in question. It would be equally legitimate to expand $f(x)-f(x-dx)$ or $f(x+\frac{1}{2}dx)-f(x-\frac{1}{2}dx)$. The notion of a differential coefficient depends essentially on the assumption that the ratio of $f(x_2)-f(x_1)$ to x_2-x_1 tends to a unique limit when x_2 and x_1 both tend to the same finite limit x. Further, we think it would be much better to follow Newton's example by defining equality of differentials instead of trying to define the differentials themselves. The student who is taught always to *add dx* on to the end of x fails to grasp the very foundation of the calculus. The failing cases may be exemplified by "density" at a point *on* the surface separating two media.

WE have pleasure in directing attention to the little volume entitled "Manchester in 1915," which has been issued (in Manchester by the University Press, and in London by Messrs. Longmans and Co.) at one shilling net, it being the handbook for the forthcoming meeting of the British Association. While less pretentious than many previous association handbooks, it is a noteworthy production, and one which should be of great service to those attending the meeting; it will doubtless also appeal to many residents in and adjacent to Manchester, for it contains some very readable and informing articles on institutions of, and matters pertaining to, the city; thus, a brief historical sketch is contributed by Prof. J. Tait; Prof. Tout deals with the University, Dr. Tattersall with the museum, Mr. H. Guppy with the John Rylands Library, and Prof. Hickson with the Literary and Philosophical Society. Mr. Spurley Hey has two articles on, respectively, elementary education in Manchester, and secondary schools in Manchester, and Mr. J. H. Reynolds deals with the evening-school system of Manchester. In addition to the foregoing, the volume is finely illustrated by some fourteen plates—one in colour. Both text and illustrations are beautifully printed.

THE Institute of Chemistry proposes to issue a special edition (limited to 100 copies) of the history of the institute, 1877–1914, and orders for it can now be received. Any profit arising out of its sale will be devoted to the building fund.

MR. W. H. DINES informs us that a mistake occurs in his letter in NATURE of August 12 on "The Probable Error of the Amplitudes in a Fourier Series obtained from a Given Set of Observations." The passage in question should read:—"To obtain p we write $np/2=y_0 \sin 0+y_t \sin\frac{2\pi}{n}$. . . . etc., instead of $p=y_0 \sin 0$ . . . .

OUR ASTRONOMICAL COLUMN.

ABSOLUTE STELLAR MOTIONS.—*Meddelande* No. 65, from the Lunds Astronomical Observatory, gives an account of an important statistical study of the distribution of the absolute motions of a number of parallax stars which has been made by Mr. K. W. Gyllenberg. After excluding parallaxes smaller than 0·015″, there remain 160 stars for which absolute velocities can be determined. The components were calculated for an axis "Z" pointed to the galactic pole, an "H" axis in the plane of the Milky Way, whilst the third "Ξ" was directed towards the vertex found for 1470 stars with known radial velocities. The numerical work was curtailed by using Prof. Charlier's plan of dividing the sky into forty-eight compartments, and using the co-ordinates of the centres for the contained stars. Prof. Charlier's units Siriometer (1 Sm = 10^6 dist. earth-sun) and Stellar-year (1 St. = 10^6 years) have been used (1 Sm/st. = 4·7375 km./sec.). After arranging the material according to type of spectrum, five star types, K1 (Arct.) to A2p (Cyg.), were excluded as having excessive velocities. The greatest mean velocities were found in the plane of the galaxy, the "Z" components giving the smallest mean value. The absolute velocities tend to increase as the parallax diminishes, but the increase is more rapid for the small parallaxes, probably due to the greater insecurity of these measures. Hence in the final stage of the work stars having parallaxes less than 0·025″ were excluded. It is concluded that the distribution of the absolute velocities for the remaining 144 stars is approximately represented by an ellipsoid of revolution flattened in the plane of the Milky Way, and, unlike the proper motions or radial velocities, the absolute motions show no principal vertex.

THE SOLAR ECLIPSE OF APRIL 17, 1912.—We have received copies of two papers by Señor P. Carrasco, of the Madrid Observatory, reprinted from the Annals of the Physical and Chemical Society of Spain, dealing with the above eclipse. One of these papers (*Ann.*, vol. xii., pp. 482–99, 1914) gives a general description of the eclipse and of the work done at Cacabelos (Leon) by Señor Carrasco, who had charge of the spectroscopic work in the eclipse party under Señor Cos, organised by the Institute of Geography and Statistics. The central line of totality, it is estimated, passed about 2700 metres south-east from the position occupied at Cacabelos (3° 1′ 39″ W., Madrid, 42° 35′ 53″ N.). The observers saw something rather less than totality, but more than a mere partial phase. In the second paper (*Ann.*, vol. xiii., pp. 181–238, 1915) the spectroscopic observations are discussed. The prismatic camera employed had "two (?) quartz prisms of 60° angle, 48 mm. in height, with an objective of 50 mm. aperture and 630 mm. f.l." *Five* exposures were made in *ten* seconds on one plate (Agfa), 13×18 cm. Three of these spectra have been measured and reduced (Cornu-Hartmann formula, Rowland's solar wave-lengths, and Kayser's Hauplinien). The results are given in a table of some 2000 chromospheric lines between λλ3334 and 5897. The ultraviolet region to λ3900 has been mapped. The conclusions reached are in good accord with those now generally accepted; thus, although Fraunhofer lines are common to both spectra, yet the intensities are notably distinct, the larger chromospheric arcs agreeing better with the spark than the arc spectrum, and the principal lines of the high chromosphere correspond with the enhanced lines of Sir Norman Lockyer.

ANOMALOUS DISPERSION IN THE SUN.—Last year Prof. Julius, by a development of the theory of anomalous dispersion, concluded that there must be

a mutual influence of closely neighbouring Fraunhofer lines. Early in the present year, however, Dr. St. John, discussing the same data employed by Julius, obtained a negative result. The matter is now carried a stage further in the June number of the *Astrophysical Journal* by Mr. Sebastian Albrecht. In this valuable paper a comparison is made of Rowland's solar wave-lengths of iron lines and the laboratory wave-lengths of the same lines to determine whether systematic differences are shown by lines having close companion and isolated lines. The paper hinges on a discussion of laboratory wave-lengths. All iron lines which have been classified according to pressure effect were examined, and consequently a chief feature of the paper is a complete list of Rowland's solar wave-lengths and corresponding international wave-lengths of these lines. International secondary standards were, of course, adopted without modification; for other lines a comparison was made between the sea-level determinations of Burns and the Pasadena-Mount Wilson values of St. John and Ware. A systematic difference so disclosed was ascribed to differences in the *internal* pressure of the arcs employed. The corrections to reduce the I. Å. values to a pressure of 0·5 atm. (the pressure of the solar reversing layer) were applied, and differences, Row., λ I. Å. 0·5 atm., as well as Row. λ I. Å. 1 atm., were tabulated. Systematic differences between Rowland and the international system were eliminated subsequently by means of a curve. The following table concisely exhibits the principal results obtained:—

Means—Displacement according to Separation of Lines.

Lines with	Separation		
	0·0 to 0·2 A	0·2 to 0·4	0·4 and greater
Companion towards red ...	+0·0103 ...	+0·0065 ...	+0·0036
,, ,, blue ...	−0·0073 ...	−0·0024 ..	−0·0010

A REMARKABLE GROUP OF SOLAR SPOTS.—The solar surface has recently displayed considerable activity, and possessors of telescopes have been much interested in the number and variety of spot groups almost continually visible. One large group which appeared during three, and possibly four, rotations forms the subject of an article by M. Camille Flammarion in the July number of *L'Astronomie.* An account is given of the solar activity during the spring months, and associated terrestrial, magnetical, and electrical disturbances.

A CATALOGUE OF STAR CLUSTERS.—The star clusters shown on the Franklin-Adams chart plates have been catalogued by Mr. P. J. Melotte (Mem. Roy. Ast. Soc., vol lx., part 5). The scale of the plates has been found excellently well adapted for the purpose, the open clusters not being dispersed by excessive magnification, whilst the scale is sufficient to show the features of globular clusters down to 3′ diameter. The catalogue contains 245 entries, and in addition to the usual co-ordinates (1900), galactic longitudes and latitudes of the various objects are also tabulated. The clusters have been classified according to degree of condensation in the following scheme of four classes:—(1) Globular clusters, condensed at centre; (2) loose clusters having regular well-defined outline; (3) loose clusters of irregular outline; (4) coarse clusters. By plotting with reference to Milky Way and classification it was found that practically all lie within ±30° of the galactic plane, whilst the globular clusters also tend to concentrate in a particular longitude rather more than half lying within 30° of galactic longitude 325°.

INDIGO IN INDIA.

THAT the production of natural indigo in India is at present receiving the scientific attention which is its due must be welcome to many. The evidence that this is the case will be found in a Report on the Improvement of Indigo in Bihar, with Notes on Drainage and on Green-Manuring, by Mr. A. Howard, Imperial Economic Botanist at Pusa, and Mrs. Howard, published in 1914 by the Bihar Planters' Association, and republished this year, with a second report by the same authors, on behalf of the Pusa Agricultural Research Institute.

The old belief that the source of the natural indigo of commerce is the species of Indigofera distinguished as *I. tinctoria*, though accepted by many chemists and some botanists in Europe down to the close of last century, was singularly incorrect. That the species in question does yield indigo is true; that at one time it was a main source of the dye is possible. It is, however, improbable that any appreciable amount of commercial indigo has been derived from *I. tinctoria* during the past hundred years.

When the intercourse between Europe and India which followed the discovery of the Cape route began, there were two main centres of indigo production and export. One of these was Surat, in Western India, where the plant employed was a form of Egyptian indigo, *I. articulata*, still the staple indigo plant in Eritrea, and still to be met with as a native crop in parts of Scinde, Rajputana, and the Deccan. The other was in Southern India, especially in Coromandel, and in Ceylon. The plant grown in this area differed much from Egyptian indigo. We may speak of it as Indian indigo, though with some reserve, because a plant from which indigo is obtained in Northern Nigeria cannot be distinguished from the Coromandel one, while a form closely related to it, which is wild in Nubia and the Eastern Sudan, has by some writers been believed to belong to this species. It is not inconceivable that the cultivated plant of Southern India may, like that of Scinde, have originally found its way east from Africa, and it is possible to imagine that on its way west from its original Nubian home to Nigeria, cultivation may have induced in it the same modifications as have taken place on its way east to Madras. The point which immediately interests us, however, is the fact that the name *I. tinctoria*, as originally employed, connotes the cultivated indigo of Coromandel.

European needs induced an extension of indigo cultivation. That of the Egyptian plant spread east from Scinde to the Panjab, and thence along the Gangetic Plain to the province of Bihar, in later times so closely associated with the manufacture of indigo. The cultivation of the Indian indigo spread to Malaya in the east, to the coasts of Madagascar, Zanzibar, and Socotra in the west; somehow, this indigo has even reached Northern Queensland. But neither plant extended to Bengal, or to Indo-China and China beyond Bengal. In Malaya the cultivation of Indian indigo went on along with that of a third plant, *I. sumatrana*, which we may speak of as Malayan indigo; this plant has found its way eastward to Formosa and, during the supremacy of the Dutch in Western India, was brought from Sumatra to Malabar, where it displaced both Indian indigo and yet another dye-yielding Indigofera. This fourth plant, *I. longeracemosa*, hardly deserves a commercial name, and only calls for mention because it has found its way to the Mascarenes and Zanzibar, and is preferred there to the other dye-yielding species.

This is not the place to discuss the policy which, early in the seventeenth century, laid an embargo on

Indian indigo, or to explain how, when that embargo was withdrawn, American indigo came to replace the Indian dye in European markets. What does interest us is that this American indigo was mainly the product of a fifth plant, *I. suffruticosa*, Brazilian indigo, grown both in South America and in the West Indies, and of a sixth, *I. truxillensis*, West Indian indigo, grown both in the West Indies, where it was the favourite indigo, and in Central America. The cultivation of Brazilian indigo spread more widely than that of any other kind; it found its way all over Polynesia, and became established in the Philippines. From Manila it extended throughout Malaya, where the Brazilian, Malayan, and Indian indigos were grown side by side, and reached Formosa, where it still competes with Malayan indigo. Similarly, this Brazilian indigo has found its way into all parts of Indo-China and into south-eastern China; in Indo-China and China this American plant is the only dye-yielding Indigofera yet known. In the opposite direction, the Brazilian indigo spread to the African coast, on the western side displacing an indigo already in cultivation, on the eastern finding a place alongside various Asiatic forms. It is interesting to note that by neither route did Brazilian indigo ever reach India.

The area occupied by the Indigofera which yielded the indigo known to the ancients extended in classical times, as it does still, from Egypt and Nubia to North-West India. Immediately to the south of the region in which the Egyptian indigo grows, from the highlands of Abyssinia as far as Zululand, occurs a seventh plant, *I. arrecta*, East African indigo, the cultivation of which has spread east to the central highlands of Madagascar and west to the coast of Guinea. Along that coast, however, from Angola to Senegal, this indigo at a later date was largely supplanted by Brazilian indigo.

The circumstances which, towards the end of the eighteenth century, led to a revival of the Indian indigo trade lie outside the scope of this article. This successful enterprise had its principal seat in the three Lower Provinces of Hindustan—Bengal, Bihar, and Orissa. The plant at first grown was a form of the Egyptian indigo; this was still cultivated in Bihar in 1812. In Bengal and Orissa, where indigo had not before been grown, this Egyptian indigo, better suited to a somewhat drier climate, was soon replaced by Malayan indigo. From Bengal, where the cultivation of indigo ultimately died out, the Malayan plant extended into Bihar, displacing the Egyptian. From Bihar this plant spread westward throughout Upper India and across the Panjab to the district around Multan, which eventually became a favourite source of the seed for the Bihar crop. From Orissa, where its cultivation likewise came to an end, the Malayan plant invaded the area in South India where *I. tinctoria* was once the staple source of the dye, displacing that Indian indigo so effectually that now *I. tinctoria* is only found in the Laccadive and the Maldive Islands, and in some parts of Ceylon, where the share taken in the eighteenth-century effort to promote the cultivation of indigo was insignificant. If, however, this Malayan plant did not reach Ceylon it was taken to Senegambia, as the "Indigotier de Bengal," to replace Brazilian indigo, and was similarly taken to the West Indies to replace *I. truxillensis*.

From Senegambia the Malayan indigo has found its way as far as Northern Nigeria, where it now grows in company with a form which cannot be distinguished from the indigo once widely cultivated in Southern India. Allusion has already been made to the possibility that the latter form may have originated in Africa, but the more probable, if more prosaic, explanation of its presence in Nigeria is that when seed of the Malayan indigo was taken to West Africa from Chandernagore in Bengal, a supply of South Indian seed was also taken from Pondicherry in Coromandel. But while we know that the first transaction took place, we can as yet only surmise the second.

In the West Indies the cultivation of Malayan indigo did not take root as it did in India and in West Africa. The effects of the competition by India had made themselves felt before the Malayan plant reached the islands. Where indigo-growing was not abandoned in favour of sugar and cotton, the West Indian plant, which was at least as valuable as the Brazilian, even if it was inferior to the Malayan one, had already been displaced by an eighth species, *I. guatimalensis*, Central American indigo.

Although Ceylon took no part in the revival of the eastern indigo trade, the Dutch East Indies did. At first, as we have seen, the Indian, the Malayan, and the Brazilian indigos were all grown; later, however, the Malayan plant, just as in India, displaced all other kinds. But in Java a further step, never adopted in India, came to be taken; Central American indigo, *I. guatimalensis*, was introduced, and displaced the Malayan plant, *I. sumatrana*. Later still, yet another displacement occurred; about the middle of the nineteenth century the East African indigo, *I. arrecta*, found its way from Zululand, through Natal, to Java; by the time that the competition of synthetic indigo had begun to be serious, this African plant was practically the only indigo cultivated in Java.

Displacements of economic species depend on economic factors. In the case of indigo, the explanation has been either that the newly adopted species was found to yield more leaf from a given cultivated area or more dye from a given weight of harvested leaf; in the case of East African indigo, it would appear that Java experience has found these two advantages combined in the same species. It was not until 1898, as Mr. and Mrs. Howard explain in their First Report, that it was realised in Bihar, where the competition of synthetic indigo had at last aroused concern, that in Java not merely one, but two, displacements of the plant which was the basis of the industry had taken place since India and Malaya re-embarked upon it in the late eighteenth century. Some Bihar planters then introduced the African plant from Java; a few seasons later direct importation of seed of *I. arrecta* from Africa took place.

The cultivation of East African indigo, which is in India termed Java indigo, though it is not a native of Java, and is in Java termed Natal indigo, though it does not grow in Natal, gradually spread until 1909–10, and bade fair to displace Malayan indigo in Bihar. An abnormal season, followed by another of the same type, then led to a check. Indigo growers became so alarmed at what they mistook for an outbreak of disease that by 1913 the area under East African indigo had fallen from 70,000 to 15,000 bighas. Had their memory enabled them to recall the experience, duly recorded at the time, with regard to the cultivation of *I. arrecta* near Calcutta, under equally abnormal conditions, ten years earlier, a suspicion might have been aroused that what was needed was the correction of some defect in the cultivation and the bestowal of some attention on the seasonal peculiarities of the East African plant. The investigation of the imaginary disease was placed in the competent hands of Mr. Parnell at Sirsiah, who in 1913 was unable to report the discovery of any pathogenic organism. Mr. Howard, who then had

an opportunity of discussing the matter, came to the conclusion that the symptoms which had alarmed growers were attributable to bad cultivation and water-logging of the soil.

Since 1913 the experimental work commenced by Mr. Parnell at the now abandoned Indigo Research Station at Sirsiah has been continued at Pusa by Mr. and Mrs. Howard, whose work, as detailed in their First Report for 1914, has satisfactorily disposed of the unfounded dread that East African indigo had in India fallen a victim to some mysterious malady. In this and in their Second Report for 1915, the authors have further shown planters how a recurrence of the difficulties experienced since 1910 may be avoided, and have taught them that a treatment with which they were familiar as regards Malayan indigo calls for modification when the East African plant is in question. But they have done more than this; in the words of a writer in the Allahabad *Pioneer*, one result of the work of Mr. and Mrs. Howard is that "one bugbear of the Java indigo planter—the impossibility of obtaining good seed—is on the highway to being removed." The beneficial effect of their work, however, does not end here; in their Second Report they point out with a directness to which the planting community have not been accustomed, that the future of their industry in Bihar will depend on their ability to increase the yield of indigo from the plant. If the advice given in the Report for 1915 be followed, there may still be some hope as to the future in store for the industry, the object of which is the production of natural indigo. It is true, as the sympathetic writer in the *Pioneer* remarks, that many improvements will be necessary if this industry is to re-establish itself. The friends of the Bihar planter—he has, and he deserves to have, many—for years past have urged this necessity upon him, and it is but fair to say that he has taken the advice to heart. But his most genuine well-wishers have not hesitated to remind him that, so far, he has failed in one important particular—he has not recognised, as he might, his own limitations. His "associations" and his "syndicates" serve many legitimate and useful purposes. But the direction of research in connection with indigo has clearly not been their *métier*, and if the two Reports by Mr. and Mrs. Howard enable this truth to be realised they will have done good which should outweigh even the immediate material benefit which they confer on a singularly deserving community.

For his attitude towards the plant and its product the indigo-planter is not wholly to blame. The stranger can teach him little with regard to the cultivation of the particular plant with which he is familiar. To his colleague the chemist there is, after all, but one indigo. When the indigo-planter knows, as the botanist tells him, that among the forty kinds of tobacco, the twenty kinds of wheat which surround his dwelling, he has to do with but one species of Nicotiana and one of Triticum; when he observes that it is easy to find two tobaccos and two wheats differing in outward characters more markedly than any two indigo plants of his acquaintance do; it is scarcely surprising if he be influenced by a subconscious belief that, after all, the indigo plants may be only forms of one Indigofera, and that the treatment suitable for one may well serve for another. Nor is it quite certain that the botanist, whose task it is to keep the planter right, is always free from a similar unwitting prejudgment. The tangled synonymy with which the history of these tinctorial species of Indigofera is loaded, and the instinctive tendency to suggest that each new one may be a modified form of *I. tinctoria*, point to this possibility. That this is not the case those who have grown the different tinctorial species together and have compared them at various stages of growth can testify; those who have made a critical herbarium study of the material available express the same judgment. Even in such as have not enjoyed these opportunities, a consideration of the history of these tinctorial indigos from a botanical point of view may perhaps induce a reservation of judgment. The hope of effecting this, and the desire to assist the planter to realise that the displacement of one indigo plant by another is nothing new and has never been unreasoned, may serve as an excuse for the *résumé* of these displacements here given.

RESEARCHES ON PHAGOCYTOSIS.

I.—*Introduction.*

ALTHOUGH the number of the white blood-corpuscles, compared with that of the red, is small (1 leucocyte to ±350 red blood-corpuscles), the absolute number of them is rather considerable; for in the five litres of blood, which is the usual quantity for a man of normal size, there are 80,000,000,000 leucocytes.

A part of these leucocytes has, owing to their plasticity, the property of enveloping and in this way taking up all sorts of particles, as, for instance, coal-dust, grains, and also bacteria. It is because of this property that these cells, which have a diameter not larger than about 0·008 of a millimetre, have engaged our attention, especially since Metchnikoff has established that bacteria englobed by these cells are killed in them, and are thus made innocuous to our body. For this reason he has called them phagocytes (eating cells), and their process of eating *phagocytosis*.

The life of these cells deserves our interest; but until now it has not been, as such, the object of a systematic investigation, a fact Metchnikoff himself regretted in a paper he read some years ago to the students of the University of Amsterdam on "Réactions Phagocytaires." [1]

Now I must confess that the importance of the phagocytes for the defence of our body against bacteria has not been the first and principal reason of my investigations with these cells: the principal reason was their being an excellent object for researches of a general biological nature.

I think a physiologist in the first place must practise science for its own sake, not asking whether his work may be of immediate practical use, but should he, however, accidentally stumble upon an idea which may be directly used for the bodily welfare of mankind, this should not prevent him from giving his attention to this; in fact, it is his duty to do so.

The phagocytes are a suitable object for studying life phenomena. In the first place, they are not such complicated organs as the muscles, heart, brain, etc.; they are simple cells, easily isolated. Secondly, it is possible to follow quantitatively the effect on their life of slight alterations of their natural medium.

It is obvious that the phenomena produced by the agency of solutions not dangerous to life are, in fact, nothing else but the effects of reactions which finally will help us to penetrate further into the physical and chemical structure of the living cell.

The investigations on the life of phagocytes, which during the last years have occupied myself and my collaborators, are a continuation of researches begun several years ago (1883) with the object of ascertaining the influence of salt solutions of various concentra-

[1] Nous ne sommes qu'au début. Lorsqu'on connaîtra mieux *la physiologie des phagocytes*, on cherchera des méthodes pour augmenter l'activité de ces éléments dans la lutte contre les microbes et on cherchera d'autres pour préserver contre l'attaque des phagocytes les cellules nobles de notre corps.

tions upon the red blood-corpuscles, and of the significance of these results with regard to the functions of the body. These researches on the red blood-corpuscles, which introduced physical chemistry into medical science, were confined to the study of their chemical and volumetrical alterations.

But the influence of the salt solutions on the very life of the cells could not well be tested on those particular objects, although systematically investigated. We have felt this from the beginning, and repeatedly asked ourselves whether the solutions producing the chemical and volumetric changes of the red blood-corpuscles had or had not seriously damaged these cells, and thus, whether it was possible to apply the conclusions arrived at to problems regarding life itself. Therefore, wherever it was possible, we examined whether the phagocytes, being submitted to the same agencies, kept their phagocytarian power. This was always the case. This conclusion enhances the value of our researches on the red corpuscles, the more so because the chemical and volumetric alterations of the white cells corresponded with those of the red ones. But a systematic study of the life of the leucocytes had not, previous to our researches, been undertaken, and this is rather surprising.

II.—*Method of Investigation.*

Our method has been very simple. White corpuscles (leucocytes) from the blood of a horse are transferred to various media mixed with very small particles of carbon. After having stood some thirty minutes in an incubator at body temperature a great many of the cells have eaten up carbon. Microscopical preparations are made, and it is ascertained what percentage of the leucocytes has taken up carbon. *This percentage is the measure for the degree of phagocytosis and gives the value of the influence of the various agents used on that function of life.*

Suppose in examining 600 leucocytes lying in their natural medium (blood serum) I find that 300 of them have taken up carbon, the percentage of phagocytosis can then be expressed by $300/600 \times 100 = 50$ per cent. In order to examine, for instance, the influence of small amounts of acid, I add this substance to the serum and repeat the same experiment under the same conditions. I now find that of the 540 examined leucocytes only 200 have taken up carbon. The phagocytosis is now expressed by $200/540 \times 100 = 37$ per cent. Thus the addition of acid to the serum has lowered phagocytosis.

This calculation is based on the principle that the phagocytic power of the individual phagocytes present in a suspension is unequal, a fact which cannot be wondered at when we take into consideration that they are of different age. The more detrimental the action of the agent, the smaller should be the number of phagocytes which take up carbon in the same space of time.

Our selection of an indifferent substance such as carbon instead of bacteria, was based upon the fact that we otherwise feared our work would become too complicated. We here refer to the fact established by Sir Almroth Wright and his school that most kinds of bacteria, before they can be taken up by the phagocytes, must undergo a certain amount of sensitisation. Hence it follows that the intensity of phagocytosis will not only be influenced by the agent, as such, but also by the degree of "sensitisation" the particles have undergone. Another fact which had to be borne in mind was that the bacteria sometimes secrete poisons, which have an injurious effect on the phagocytosis. Even dead bacteria contain poisons.

The selection of carbon as an indifferent substance instead of the usual grains of carmine was based upon the greater facility and accuracy with which the taking up of carbon can be ascertained. I shall not here give a detailed description of the method of obtaining the leucocytes, or of preparing the carbon, or of the method of determining the percentage of cells which have eaten carbon. I prefer to give some of the more striking results.

III.—RESULTS.

(1) *The Influence of Small Amounts of Calcium.*

In examining systematically the influence of the addition of small amounts of various salts (ions) to the blood-serum, it was found that very small quantities of calcium increased the phagocytosis to a considerable extent. An addition, for instance, of 0·005 per cent. of chloride of calcium ($CaCl_2$) to the natural medium (serum) caused an increase of about 22 per cent. in the phagocytic power. This favourable effect becomes even more strongly manifest when, instead of being added to the suspension of phagocytes in serum, the calcium is added to a suspension of phagocytes in a solution of chloride of sodium (common salt), in which phagocytosis occurs almost to the same extent as in serum.

These investigations have been continued in two directions. In the first place, we asked ourselves whether the influence of calcium would also manifest itself in the living body. All experiments had hitherto been made outside the body. It will be remembered that on placing under the skin (for instance, on the inside of the thigh of a rabbit) small capillary tubes, closed at one end and filled with an extract of bacteria in a solution of chloride of sodium, phagocytes enter these tubes. This phenomenon is called Chemotaxis, and is based upon the creeping movement of the phagocytes towards the excretions and secretions produced by the bacteria.

After a certain lapse of time, the open part of the capillary tube is filled with a white column consisting of phagocytes. If, in fact, calcium promotes the activity of the phagocytes, not only in the phagocytic process described above, but also in the living body, we argued it might be expected that by calcium that mobility of the cells, which here finds its expression in chemotaxis, would be accelerated. Therefore we determined the length of the white column formed in the capillary tube with animals, either treated with calcium or not so treated.

We expected to find that in rabbits treated with calcium the white column would after the same space of time be longer than in animals not having been treated with calcium. We have used two methods, which gave the same result. I will mention one only. It consisted in injecting into the rectum of two series of animals a solution of chloride of sodium mixed for one series with calcium, and for the other without calcium, and then examining the length of the column of phagocytes penetrating into the capillary tubes.

The difference between the two series was considerable. The calcium-rabbits showed the greatest degree of chemotaxis, although the amount of chloride of calcium used was very small, viz., 0·06 gr., a quantity corresponding with that given to man in mineral waters rich in calcium. Let us add that a natural mineral water used in our experiments gave the same results as the chloride of calcium solution.

What can be said of the mechanism of this effect? The calcium, on being absorbed by the mucous membrane of the rectum, enters the blood-circulation and by this is carried into the lymph of the tissue-spaces; where the glass capillary tubes are placed. The phagocytes which are there will soon undergo the stimulating influence of the calcium thus introduced, *i.e.* their mobility will be increased and chemotaxis will be promoted.

Even without measuring the length of the phagocyte columns, we may convince ourself that our conclusion as to calcium promoting the activity of the phagocytes is the correct one. On opening the skin wound, it is immediately seen that in the mineral-water-rabbits a much thicker mass of phagocytes is gathered round the tubes than in the pure sodium-chloride-rabbits. The same thing we observed invariably in all experiments where NaCl-solution containing calcium-chloride was injected.

Taking for granted that phagocytosis is playing a part in defence against microbes, we may infer from the above that an enrichment of our blood, and through this also of the lymph spaces, with small amounts of calcium must have a favourable effect on local and other infections.

There are many experiences supporting this view. I will mention only two examples. In the first place, Sir Lauder Brunton has used with great success chloride of calcium in pneumonia. Other clinicians have also met with success along the same lines; for instance, Crombie, who some years earlier, in the hospital of Calcutta, saw the mortality decrease from 38·6 to 5 per cent. He is inclined to attribute the influence of calcium to an action on the poison excreted by the pneumonia bacteria. But for this there is no evidence. Sir Lauder Brunton has recommended calcium for getting amelioration of the heart-action. In recovery from pneumonia the amelioration of the heart-action is of the greatest importance. So it was quite rational that the famous clinician and pharmacologist advised calcium for this purpose: in the first place, because it was pointed out by the work of Sydney Ringer that calcium is absolutely necessary for the heart-function, and, on the other hand, Langendorff and Hueck had found that by the injection of calcium into the circulation of a cat the action of the heart was considerably strengthened.

Sometimes it happens that during surgical operations the heart-beat is stopped by the inhalation of chloroform. The idea occurred to me that in this case calcium might be able to be of good service. Therefore I tried to improve the heart-action by intravenous injection of calcium in animals, which had been given purposely too much of the anæsthetic. I had no success; so I began to doubt whether calcium was really capable of stimulating even the normal heart. In a number of experiments I made I found that injection of calcium had no effect on the heart-beat of a normal animal. Studying the original article of Langendorff with renewed attention, I saw that he had performed only one experiment. His great reputation had given his assertion general acceptance, and so it had become a fact in the literature. Obviously the amount of calcium in the normal blood-serum provides already just the optimum quantity for the heart function.

Thus this favourable effect of calcium in pneumonia not being explained by the influence of calcium on the heart, we had to look for another reason. It was therefore most natural to remember the stimulating action of the calcium on phagocytes, which in pneumonia play such a preponderant part.

My second argument for the probability that calcium is of importance in infectious diseases is this: labourers in lime-kilns do not get tuberculosis; in Holland these workmen cover any wound they receive with lime.

The significance of calcium has for some time past been occupying the special attention of biologists and pathologists in an increasing degree, and I shall speak of it further now, and of the cause of the promoting of the activity of the phagocytes in phagocytosis and chemotaxis by calcium, only to make one remark. We might be inclined to attribute the increase of the plasticity to a modification in the aggregation of the colloid-protoplasm-particle as a consequence of the electric charge caused by the entering of a number of bi-valent calcium ions into the cells. This explanation, however, can scarcely be the correct one here; for experiment shows that other bi-valent kations, namely, barium, strontium, and magnesium, do not augment the amœboid motion, *i.e.* of phagocytosis and chemotaxis. It must be assumed, then, that the action of calcium in this case is based upon a hitherto unknown specific biochemical property of this metal.

(2) *Influence of Iodoform on Phagocytosis.*

Everyone knows that for the last thirty years iodoform has been successfully applied in the treatment of wounds and chronic inflammations. At first it was thought that this favourable effect was based upon an antiseptic action, but the idea was relinquished when it was found that lower organisms develop fully in a medium containing iodoform. Then other hypotheses were suggested, which need not be dwelt on. They are founded mainly on iodine being split off. None of these have proved satisfactory suggestions. For reasons unnecessary to state here, we have raised the question whether the favourable effect of iodoform on local infections may be due to the stimulating effect of this substance on phagocytosis. To answer this question iodoform solutions of different concentrations in a common salt solution of 0·9 per cent. were prepared and mixed with a thick suspension of white blood-corpuscles. After having added carbon particles, the mixtures were left to themselves for half an hour in an incubator at 37° C., and then cooled down. Finally, microscopic preparations were made and examined to determine what percentage of the total number of white blood-corpuscles had taken up carbon particles. The following table contains the results of the experiment.

Concentration of Iodoform Solutions in which the Effect on Phagocytosis is still perceptible.

Fluids	Percentage of leucocytes having taken up carbon	Per cent.
NaCl 0·9 per cent. (common salt solution of 0·9 per cent.)	$\frac{171}{388} \times 100 = 44$ $\frac{151}{345} \times 100 = 43·7$	43·8
1 iodoform to 100,000 NaCl 0·9 per cent.	$\frac{221}{374} \times 100 = 58·6$ $\frac{226}{377} \times 100 = 59·9$	58·2
1 ,, 500,000 ,, ,,	$\frac{228}{371} \times 100 = 61·4$	61·4
1 ,, 2,000,000 ,, ,,	$\frac{208}{398} \times 100 = 52·2$ $\frac{231}{445} \times 100 = 51·9$	52
1 ,, 5,000,000 ,, ,,	$\frac{292}{021} \times 100 = 46·9$ $\frac{176}{372} \times 100 = 47·3$	47

This table shows that, in the pure salt solution, of the 388 examined leucocytes 171 have taken up carbon, *i.e.* 44 per cent. In a parallel experiment the percentage was 43·7 per cent. Thus the average was 43·8 per cent. In the salt solution containing iodoform in a proportion 1 gr. iodoform to 100·000 gr. NaCl solution, the percentage in two parallel experiments was 58·6 and 59·9; average 58·2 per cent. Evidently the iodoform promoted phagocytosis.

These and other parallel experiments illustrate also the exactitude of the method. As a matter of course, control experiments have been made in all cases.

Further, it appears that a weaker solution of iodoform (1 : 500,000) yields a still higher phagocytosis (61·4 per cent.). The explanation of this phenomenon will afterwards be given. It is seen that in still weaker concentrations the phagocytosis is diminished, but even in a solution of 1 iodoform to 5,000,000 salt solution, the promoting effect of iodoform is still perceptible, for it is 47·1 per cent., whereas in a pure NaCl solution it was $\frac{1}{2}(44+43\cdot7)=43\cdot9$ per cent.

The favouring effect of iodoform is still more evident when the leucocytes are placed for several hours in a pure NaCl solution. Then the phagocytosis falls to a considerable extent. Sometimes the phagocytes are quite paralysed. The addition of iodoform in a concentration 1 : 5,000,000 then raises the phagocytic power by 30 per cent. or more. Thus there is no doubt that iodoform is able to promote phagocytosis. *Is it the iodine or the iodoform as such?* We have found that iodine is noxious in a high degree. We must conclude, therefore, that iodoform as such causes the increase of the phagocytic power.

The question now suggests itself: How can the favourable effect of iodoform be explained? It may be accepted from numerous investigations that the outer layer of the cells consists of a fatty substance, a so-called lipoid membrane. Now iodoform is soluble in fat, and it is quite obvious that such a membrane will grow more soft and more flexible after having absorbed iodoform, and that consequently the plasticity and mobility will be facilitated.

If this interpretation be correct, then other substances soluble in fat, such as chloroform, chloral, alcohol, benzine, camphor, fatty acids (propionic, butyric acids) should affect phagocytosis in a similar way. This is found to be invariably the case.

(3) *Effect of Chloroform, Alcohol, Camphor, Benzine, and other Substances Soluble in Fat on Phagocytosis.*

I shall not give an account of all our experiments made in this direction. I only give as an example an experiment with chloroform, from which one can at once get an idea as to the exactitude of the method. It was soon found that dilutions 1 : 2000, 1 : 6000, and also 1 : 10,000 paralysed the phagocytes. The following table contains some experiments with weaker solutions :—

Effect of Chloroform on Phagocytosis.

Fluids	Percentage of leucocytes having taken up carbon	Per cent.
NaCl 0·9 per cent.	$\frac{174}{428}\times 100=40\cdot6$	40·9
	$\frac{238}{562}\times 100=41.2$	
Chloroform 1 : 20,000	$\frac{244}{480}\times 100=50\cdot8$	50·3
	$\frac{225}{451}\times 100=49\cdot8$	
,, 1 : 100,000...	$\frac{254}{519}\times 100=60\cdot6$	60·3
	$\frac{382}{455}\times 100=60\cdot1$	
,, 1 : 500,000...	$\frac{332}{582}\times 100=57$	58
	$\frac{219}{370}\times 100=59\cdot1$	
,, 1 : 5,000,000	$\frac{379}{868}\times 100=43\cdot6$	44·3
	$\frac{298}{661}\times 100=45$	

From this table it appears that chloroform 1 : 20,000 raises the phagocytosis power from 40·9 per cent. to 50·3 per cent.; further, that phagocytosis is considerably increased by chloroform 1 : 100,000, in which case it rises to 60·5 per cent. Evidently in the chloroform-solution 1 : 20,000 the paralysing influence also makes itself felt. In a dilution of 1 : 500,000 the favourable effect remains to about the same extent as in 1 : 100,000, and finally in a solution of 1 chloroform to 5,000,000 NaCl-solution, this favourable effect is still visible, though slight.

Similar results were obtained with benzine, camphor, turpentine, alcohol, chloral, fatty acids (propionic and butyric), and also Peruvian balsam. These all, without exception, promoted phagocytosis. Hence our hypothesis for explaining the effect of iodoform was fully confirmed. Another strong support to our hypothesis was obtained by comparing the concentrations of the named substances which were able to increase phagocytosis. It appeared that the relation between these concentrations corresponded with that existing between the solubility of these substances in fat.

Further, all the substances applied in very small doses showed a stimulating effect, but paralysed when given in greater quantities. This can be explained by distinguishing two factors. First, slight quantities of the substance by dissolving in the outer layer of the cell weaken it and increase the plasticity and mobility. Then, greater quantities having entered the cell, a second factor, the paralysing effect on the protoplasm, comes into play. As the amount of chloroform is increased, the paralysing effect gets the precedence and no carbon at all is taken up.

4. *Other Phenomena seen in the Light of the Foregoing Facts.*

The effect of fat-dissolving substances on phagocytes throws a new light on several facts which were until now for the most part entirely unexplained. In the first place, we may refer to the power of turpentine to cause local exudations, and the favourable effect of a subcutaneous injection of the same substance in the treatment of pneumonia with horses and of mastitis with cows, which for some time has been practised with great success in France, Denmark, and Holland. Experiments made by us in this direction have shown that there is much reason to attribute this effect to very small quantities of turpentine dissolving in the lymph of tissue-spaces and afterwards entering the blood circulation and promoting the phagocytic power of the phagocytes in lung and udder.

In the same way we can explain the marked effect of camphor-treatment in inflammatory processes of the uterus and its adnexa, an effect not understood hitherto. Then there is the great effect of covering infected wounds with "balsam of Peru," the therapeutic value of inhalation of turpentine-vapour in tuberculous and other infectious processes in the respiratory organs.

In all these cases a stimulating action on the phagocytes, and probably also on other cells (granulation-cells), which play a part in the healing process, may come into play. Yet more becomes clear to us from the above researches.

It is well known that various narcotics applied in smaller doses have a stimulating effect and paralyse in greater quantities. Engelmann observed this many years ago on ciliated cells, but he did not try to explain it. Also as regards the nervous system we know with regard to chloroform and ether that, when administered, they first cause excitement and afterwards insensibility. So far as we know, this contrast has never been explained, but when viewed in connection with our experiments, the phenomenon becomes clear. In the beginning of narcosis only small quantities have entered into the nerve cells. The consequence is a softening in the first place of the outer layer. This weakened state of the cells produces an

increase of activity (amœboid motion?). Later, when a greater amount of the substance has been taken in, the paralysing effect gets the upper hand. With alcohol the same experience is well known.

In following this point we are led to think of the remarkable influence of a sojourn in high mountain regions, on metabolism, on sleep, and on the state of the mind. The cause is entirely unknown. It has been proved that these phenomena are not due to the height as such, for in balloons they do not occur, nor are they found in high mountain regions, but when examining where they are observed, we find that it is in the neighbourhood of coniferous woods. So we are inclined to think that it is due to the stimulating effect of the odour of resin (turpentines, etc.) on the nerve-cells.

Prof. Sherrington and Miss Sowton, in their studies on the dosage of the mammalian heart by chloroform, found that, especially with greater amounts of the drug, it was usual for the first effect of the administration to be a distinct though slight increase in amplitude of the contractions. After cessation of the administration of the drug in moderate dose, it was not unusual before the recovery of the beat for the heart to pass over for a short time into a condition of super-activity. These phenomena suggest an irritative excitatory effect of small doses of the substance on muscle or nerve-fibres (or both) of the heart. These results agree with those previously obtained by Prof. A. D. Waller in his experiments with the isolated nerve.

There are experiments also with other organs which may be considered in the same light. Thus Prof. J. Loeb discovered that substances dissolving fat have the power of rendering possible the parthenogenetic development of eggs. Now we may imagine, with Loeb, that the substance dissolves in a lipoid of the outer layer of the egg, thus giving rise to the formation of a fertilising membrane. We think we may safely go one step further and assume that it is owing to the weakening of the membrane that the movement of the protoplasm underlying every cell division manifests itself. This view is confirmed by the observation of Prof. R. S. Lillie, who saw also that by a short transitory raising of the temperature in the eggs of starfishes a typical fertilising membrane may be formed, which formation is followed by the development of part of the eggs into larvæ. J. Loeb was able to confirm this for Medusæ.

After consideration of the foregoing facts and suggestions, we were inclined to think that the stimulating effect of traces of substances which dissolve fat on the activity of cells is a widespread phenomenon. Hence we have investigated whether this influence might also be seen in *plant-cells*. To do so, we chose the germination of seeds, a process in which a considerable division and growth of cells manifests itself. The seeds we chose were grains of wheat, and for the fat-solvent we took chloroform. With chloroform, 1 part to 100,000, an important acceleration in the germination was observed; chloroform 1 to 1000, on the contrary, impaired the germination, evidently because a second factor made itself felt, viz. paralysis of the protoplasm. Later I heard that in practice the growth of snowdrops is promoted by ether. In recent times Chiari succeeded in forcing blossoms to a considerable extent by ether-vapour, and Mansfield the germination of pumpkin-seeds by vapour of alcohol and ether.

Hence it is clear that the observations on phagocytosis deserve our attention on general grounds as well as special. We do not at all mean to say that all substances dissolving fat have the same effect on cells of all kinds; far from it. I would emphasise that, in order to be brief and to avoid complexity of detail, I have here presented the matter somewhat simpler than it really is. Nor have all the suggestions here made towards explaining facts regarding other cells than phagocytes been actually proved. Without hypothesis, science cannot progress. Fortunately we need not stay in error for long, for we can always appeal to the supreme judge, experiment.

This account of results and views, the fruit of some years' work with several collaborators (Hekma, de Haan, etc.),[2] being of necessity incomplete, I have attempted to select what may specially interest the general scientific reader.

We are continuing our study of the biology of phagocytes, and each day we become more convinced of their excellence as a simple object, for the study of problems of a general biochemical nature, and for some of practical interest as well.

H. J. HAMBURGER.

IRELAND'S INDUSTRIAL OPPORTUNITIES.

A LECTURE delivered in April last before the Insurance Institute of Ireland by Mr. George Fletcher, the assistant secretary of technical instruction, and recently issued in pamphlet form, deserves the serious attention of all well-wishers of Ireland. We have in Ireland a population little more than half of what it was in 1841, and which is now annually depleted by emigration to such an extent that any increase in its population is well-nigh impossible.

It is obviously, therefore, of the highest possible importance to the well-being, not merely of Ireland, but also of the kingdom generally, that means should be taken to ensure the utmost development alike in agriculture as in manufactured products, since it is now clearly realised that it is only by a combination of both that the well-being of Ireland can be firmly established.

The Department of Agriculture and Technical Instruction established in 1899, mainly through the strenuous efforts of Sir Horace Plunket, the first vice-president, has done much for the promotion of agriculture and its products and of manufacturing industry. Improved methods have been introduced into farming, fishery, and industrial operations, especially in the latter case by the encouragement of cottage industries, with a view to find employment for the rural population in times and seasons not devoted to agricultural work, and with a view also to add to the interest of an otherwise monotonous life.

Large sums have been spent as a result of local and Governmental effort in the promotion of technical education, with the result that now practically all over Ireland facilities exist for the due training of the workers engaged in agricultural and industrial pursuits. At the same time, the Department has persistently urged the necessity, if technical training is to be of any real value, of a better and more pervading system of elementary and secondary education upon which to found it, and also for the reason that it is desirable to widen by means of a sound general education the mental horizon of the people.

Believing that no permanent good can be ensured except by the co-operation of the people themselves, it has been the aim of the Department to encourage the formation of associations of farmers and manufacturers, so as to secure a sense of solidarity and of common effort.

[2] A full account of the researches as far as the year 1912 can be found in my monograph "Physikalisch chemische Untersuchungen über Phagozyten. Ihre Bedeutung vom allgemein biologischen und pathologischen Gesichtspunkt." (Wiesbaden: J. F. Bergmann, 1912.)

The example of Denmark has proved a potent influence in the measures which have been taken to develop the agricultural resources and products of Ireland. The export value of eggs, butter, beef, mutton, pork, bacon, and hams from Ireland was in 1912 11,820,356*l.*, but in 1913 we received from Denmark alone butter, eggs, and bacon to the value of nearly twenty-two millions sterling.

It cannot be said that this huge difference in value is attributable to a better soil or climate, and, as a matter of fact, it is entirely due to the better education of the people, to a more scientific treatment of the soil and of the animals concerned, and to a stronger sense of the advantages of co-operative effort. It is clear that given these conditions, Ireland, with its much larger acreage and more productive soil, could raise for export the greater part of this importation of food products; and as with agriculture, so with the smaller factory and cottage industries. It is made clear in Mr. Fletcher's address that there is abundant scope for their establishment and development, of which Belgium affords a striking and pregnant example, which the people of Ireland would do well to follow, and thus bring the small town and the countryside into close and harmonious relation.

J. H. REYNOLDS.

AEROPLANE STABILITY.

SOME phases of fore-and-aft or longitudinal equilibrium in flying are discussed by Dr. Orville Wright in a recent publication of the Smithsonian Institution, entitled "Stability of Aeroplanes." Although a beginner finds most difficulty in mastering the lateral control, it is his lack of knowledge of certain features of the fore-and-aft equilibrium which leads to most of the serious accidents.

In an ideal flying machine the centre of gravity would lie in the line of the centre of resistance to forward movement and also in the line of thrust, but in practice this is not always feasible, since the machine must be built to land safely as well as to fly. In flying, a low centre of gravity—that is, one below the centre of support, causes an oscillating movement about the lateral axis like that of a pendulum. On the other hand, a high centre of gravity tends to cause the machine to roll over in landing, and consequently a compromise is adopted.

The two principal methods used in preserving fore-and-aft equilibrium have been the shifting of weight so as to keep the centre of gravity in line with the changing centre of lift, and the utilisation of auxiliary surfaces, known as elevators, to keep the centre of pressure in line with a fixed centre of gravity. The first method has been found impracticable on account of the impossibility of shifting large weights quickly enough, but the second is used in most of the modern flying machines.

Flying machines of the latter type should have their auxiliary surfaces located in the front or rear as far as possible from the main bearing planes, because the greater the distance the greater is the leverage, and consequently the smaller the amount of surface required. No part of either the main surface or auxiliary surface should be exposed on their upper sides in a way to create a downward pressure for maintaining equilibrium.

The downward pressure of air is used to some extent, however, on account of its adaptability, in producing more or less inherent stable aeroplanes. Dr. Wright describes an aeroplane in which equilibrium is maintained by an arrangement of surfaces so placed that when a current of air strikes one part of the machine, creating a pressure that would tend to disturb the equilibrium, the same current striking another part creates a balancing pressure in the opposite direction. This compensating or correcting pressure is secured without the mechanical movement of any part of the machine. While this system will control a machine to some extent, it depends so much on variation in course and speed as to render it inadequate to meet the demands of a practical flying machine.

In order to secure greater dynamic efficiency and greater manœuvring ability, auxiliary surfaces mechanically operative are used in present flying machines instead of the practically fixed surfaces of the inherently stable type, but they depend to a greater extent upon the skill of the operator in keeping equilibrium. If the operator were able to "feel" exactly the angle at which his aeroplane meets the air, at least 90 cent. of all aeroplane accidents would be eliminated. Instruments for this purpose have been produced, but they are not in general use. The average flier does not realise how dangerous it is to be ignorant of this angle, nor does he know when he is "stalling." By "stalling" Dr. Wright means coming to rest in the air, or nearly so.

The danger from "stalling" comes when the operator attempts to check the machine's downward plunge by turning the main bearing surfaces to still greater angles of incidence, instead of pointing the machine downward, at a smaller angle of incidence, so that the speed can be recovered more quickly. Most of the serious accidents in flying occur, after long glides from considerable heights with the power reduced, when an attempt is made to bring the machine to a more level course several hundred feet in the air. The machine quickly loses its speed and becomes "stalled." Those who have seen the novice make a "pancake" landing have seen the beginning of a case of "stalling" which might have been fatal had it taken place at a height of 100 or 200 ft. in the air.

The greatest danger of flying comes from misjudging the angle of incidence. If a uniform angle were maintained, there would be no difficulty in securing fore-and-aft equilibrium. Experiments made during the past year or two have brought about a considerable advance in the development of automatic stability. A device described by Dr. Wright comprises a small horizontal wind-vane so mounted on the machine as to ride edgewise to the wind when the machine is flying at the desired angle of incidence. In case the machine varies from the desired angle, the air will strike the vane on either its upper or lower side. The slightest movement of the vane in either direction brings into action a powerful mechanism for operating the controlling surfaces. If the wind strikes the vane on the underside the elevator is turned to cause the machine to point downward in front until the normal angle is restored, and if the air strikes the vane from above, an opposite action upon the elevator is produced. The author maintains that a machine so controlled is not liable to "stalling." Another method for maintaining fore-and-aft equilibrium utilises the force of gravity acting on a pendulum or tube of mercury, and a second employs the gyroscopic force of a rapidly revolving wheel. In both these systems, however, the angle of the machine is regulated with reference to the horizontal, or some other determined plane, instead of the angle of the impinging air. Other faults render the pendulum and mercury tube useless in regulating fore-and-aft equilibrium, although the pendulum is found to be useful in regulating the lateral stability.

MINERAL INDUSTRY OF CANADA.

THE Canadian Department of Mines has issued, almost simultaneously, the annual report on the mineral production of Canada during the calendar year 1913 and the preliminary report on the mineral production of Canada during the calendar year 1914. Neither of these reports presents any feature of outstanding interest, except that the effect of the war upon the mineral industry of Canada is here made evident. The value of the output in 1913 showed an increase of 7·84 per cent. upon that of the previous year, whilst that for 1914 shows a decrease of 11·8 per cent. from that of 1913. It is, of course, not absolutely clear that the decrease is wholly due to the war. For example, the silver production of Canada, which showed a slight decrease already in the former year, has fallen about 16 per cent. in the latter year; the silver production is due in very great measure to the output of the Cobalt district, Ontario; in 1904, when the production of this district commenced, the annual production of silver was 3½ million ounces, whereas in 1910, when it reached its maximum, it was nearly thirty-three million ounces, and silver ranks second in total value only to coal amongst the mineral products of Canada, having amounted to 14·4 per cent. of that total in 1913. Both the amount of silver and the grade of the ore got in the Cobalt district have shown a gradual decline of recent years, and there appear to be some reasons to suppose that the life of the mines in this district is not likely to be a long one. A decrease in silver production might therefore have been expected normally, and it is quite possible that the part played by the European war in the recorded decrease is not an important one. Other decreases, such as those in coal, pig-iron, cement, and clay products, are, on the other hand, to be referred in all probability entirely to the war crisis. The three former showed substantial increases in 1913 over the previous year, and although the clay products fell off in value in that year, this was due merely to a temporarily decreased demand for brick, owing to the unfavourable financial position, which seriously limited building operations in the Dominion. A careful study of the two reports indicates no ground for supposing that the mineral industry of Canada is in other than a thoroughly sound condition, or that its expansion in the future will be unable to keep pace with any demands that may be made upon it.

EXPLOSIVES.

THE Smithsonian Institution, Washington, has recently issued an article by Major Edward P. O'Hern, of the Ordnance Department, U.S. Army, which deals with the composition, methods of employment, and results obtained with explosives.

The author divides explosives into three classes: progressive or propelling explosives, known as low explosives; detonating explosives or high explosives; and detonators or fulminates. For all classes the effect of the explosion is dependent upon the quantity of gas and heat developed per unit of weight and volume of the explosive, the rapidity of the reaction, and the character of the confinement, if any, given the explosive charge. The rapidity of reaction varies greatly with different explosive substances and with the manner in which the explosion is started.

Black gunpowder, smokeless powder, and black blasting powders are known as low explosives, for certain of which, such as smokeless powder, the explosion does not differ in principle from the burning of a piece of wood or other combustible. The combustion is very rapid, but is a surface action proceeding from layer to layer until the grain is consumed. Such materials are known as low or progressive explosives, although the total power developed through the combustion of a unit weight may be very great, and would be destructive unless properly controlled.

In high explosives, such as dynamite, nitroglycerin, gun-cotton, some blasting powders, and most of the "permissible explosives" approved by the U.S. Bureau of Mines for use in mines where gas explosions are liable to occur, the progress of the explosive reaction is not by burning from layer to layer, but the breaking up of the initial molecules gives rise to an explosive wave which is transmitted with great velocity in all directions throughout the mass, and causes its almost instantaneous conversion into gas. The velocity of propagation of the detonating wave has been determined for some materials to be more than 20,000 ft. per second, or approximately four miles per second; this form of material is used in shells and for bursting purposes. The progressive emission of a gas from a low explosive, such as burning gunpowder, produces a pushing effect upon a projectile, whereas the sudden conversion of an equal weight of material into gas, as would happen with a high explosive such as dynamite or nitroglycerin, would develop such high pressure and shattering effect as to rupture the gun.

The action of fulminates is much more brusque and powerful than that of the high explosives. Since they can be detonated by shock or the application of heat, they are used in primers and fuses to start action in both low and high explosives. The most important is fulminate of mercury, which produces a pressure of about 48,000 atmospheres.

At no time in the history of the world have explosives played such an important part in deciding the destiny of nations as they are playing to-day in the prosecution of the present war. Their extensive use in the mighty engines of destruction, such as the submarine mine, the torpedo, and in projectiles thrown from cannon to great distances with marvellous accuracy, is resulting in loss of life and destruction of property on an unprecedented scale.

Beginning with black powder, the earliest record of which in actual war was in the fourteenth century, the author follows the development of powder through its early stages of brown powder to the two principal forms of smokeless powder for military purposes—nitro-cellulose and nitro-glycerin—stating that the use is quite evenly divided; the U.S. Army and Navy, the French Army and Navy, and the Germany Army using the former, and the British Army and Navy and the German Navy using the latter. He then gives much detailed information concerning the manufacture, life, source of supply, and tests of smokeless powder manufactured from nitro-cellulose or gun-cotton. Following which, subjects relating to life of guns, bursting charges for projectiles, armour-piercing projectiles, high explosive shells, shrapnel, fuses, aeroplane bombs, means of igniting explosives, mines, torpedoes, and the storage and shipment of explosives in the United States are discussed.

THE BONAPARTE FUND FOR THE YEAR 1915.

THE committee appointed to consider the requests for assistance from this fund have examined twenty applications, and made the following proposals, which were accepted by the Academy:—

3000 francs to Auguste Lameere, professor at the University of Brussels, to assist him to continue his researches at the zoological station of Roscoff.

4000 francs to M. Le Morvan, assistant astronomer

at the Paris Observatory, for the publication of the photographic and systematic chart of the moon.

2000 francs to Paul Vayssière, to assist him in the continuation of his researches on cochineal insects.

3000 francs to M. de Zeltner, as a contribution to an expedition he proposes to make in the Sudanese Sahara, more particularly in the Aïr massif.

2500 francs to L. Bordas, to aid in his investigations relating to insects which attack forest trees, and more especially of those species now causing great damage in the woods of the Central Plateau and the west of France.

3000 francs to Joseph Bouget, for realising his cultural experiments on a larger scale, with reference to the afforestation and improvement of pastures in the Pyrenees.

3000 francs to Henry Devaux, for the continuation of his researches on the cultivation of plants in arid or semi-desert regions.

2000 francs to Victor Piraud, to enable him to continue his studies on the fauna of torrents and Alpine lakes, particularly at high altitudes.

2000 francs to M. Tiffeneau, for the continuation of his studies on the phenomena of molecular transposition in organic chemistry.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The following awards at Newnham College have been made:—An associates' fellowship of 100*l.* for three years, tenable from October, 1915, to Miss Ruth Holden, who proposes to continue her work in fossil botany; a Mary Ewart travelling scholarship of 300*l.*, divided between Miss H. J. Hartle and Miss M. N. L. Taylor; the Mary Ewart scholarship of 100*l.* for three years to Miss K. M. Tillyard; the Marion Kennedy studentship of 100*l.* to Miss E. E. H. Welsford; the Gilchrist studentship of 100*l.* to Miss C. Stoney; a Bathurst studentship of 75*l.* to Miss M. W. Jepps; the Harkness studentship of 70*l.* to Miss E. W. Gardner; the Arthur Hugh Clough scholarship to Miss P. M. Sargent.

LEEDS.—The William Walker scholarship, of the annual value of 90*l.*, for the scientific study of leather with a view to its subsequent application to industrial development, and the William Walker exhibition for instruction in the technology of coal and its by-products, are announced. The endowments have been founded in memory of the late William Walker, of Whitehaven, by his widow and two sons, who have placed 4500*l.* in trust for the purpose.

THE Institution of Naval Architects' scholarship, value 100*l.* per annum, and, subject to the regulations governing the same, tenable for three years, has been awarded to T. S. D. Collins.

MR. G. H. SHULL, of the staff of the Station for Experimental Evolution, Cold Spring Harbour, Long Island, has been appointed professor of botany and genetics at Princeton University, Princeton, New Jersey.

THE issue of the *Lancet* for August 28 is the "Students' Number," devoted almost entirely to information respecting the medical examining bodies and the courses of instruction given in the various medical schools and colleges of the United Kingdom.

THE following appointments to the Indian Educational Service have been made by the Secretary of State for India:—Mr. Harold Tinker, professor at the Training College, Allahabad; Mr. G. H. Geach, principal of the Training College, Peshawar; Mr. W. Saunders, professor of chemistry in the Civil Engineering College, Sibpur, Bengal; Miss E. E. Spencer, inspectress of schools in the United Provinces.

AN examination in biological chemistry, bacteriology, fermentation, and enzyme action will be held in connection with the Institute of Chemistry, beginning on October 18. The list of candidates will close on September 14. An examination in chemical technology will be held in October, but the actual date will be announced later. Notification from intending candidates must be received by September 14.

WE are informed that Mr. E. Lovett, who has formed a collection of children's toys, playthings, and games, has presented the collection to the Borough Council of Stepney, and that it is to be exhibited at the Whitechapel Museum. It will be arranged in ten sections, viz., locomotion and transport, dolls, animals, habitations, farming and agriculture, mining, manufactures and commerce, the household, playthings, games, sundries, *i.e.* toys and games of antiquity; toys made of natural objects, such as shell, bone, stone, nuts, etc.

THE Department of Agriculture and Technical Instruction for Ireland has issued a number of pamphlets in preparation for the work of the coming academic year. These include the "Programme for Technical Schools and Classes," in which it is pointed out that the regulations for technical schools and classes which were in operation during the session 1914–15 will continue in force during the session 1915–16. The "Programme of Experimental Science, Drawing, Manual Instruction, and Domestic Economy for Day Secondary Schools" has undergone no alteration, and the work next year will follow on the lines previously laid down. The "Special Course in Experimental Science: Physiology and Hygiene" has been revised.

THE Education Committee of the Staffordshire County Council has issued its "Directory for Higher Education, 1915–16." The directory contains the regulations of the committee and details of schemes in operation throughout the administrative county. Owing to the necessity of publication before the commencement of the new session it has not been possible to make final arrangements with regard to some of the classes, and, as the directory points out, some readjustments and alterations may be necessary later. One or two typical instances of the thoroughness with which the committee has provided for the needs of the county in higher education may be given. On account of differences of character between the North and South Staffordshire coalfields, and for other reasons, separate schemes of instruction in mining have been worked out for the two districts. Such instruction in the North Staffordshire coalfield is provided by the County Education Committee and the Education Committee of Stoke-on-Trent working in co-operation. The principal centre at which instruction is given is the Central School of Science and Technology, Stoke-on-Trent. This is a specialised school adapted to the needs of potting and mining, the principal industries of the district, and equipped for the study of the technology of these industries up to the most advanced grade. In South Staffordshire a general scheme of instruction in mining is designed to extend over six years, and classes in connection with it are held at several centres. At the new County Metallurgical and Engineering Institute, Wednesbury, theoretical and practical classes are held in metallurgy, iron and steel manufacture, and subjects related to engineering. Other branches of technological science in which special facilities have been provided are:—Pottery and porcelain manufacture, boot and shoe manufacture, silk manufacture, and horticultural and smaller agricultural industries.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 23.—M. Ed. Perrier in the chair.—G. **Humbert**: The reduction of the forms of Hermite in an imaginary quadratic body.—MM. **Costantin** and **Bois**: Three types of commercial vanilla of Tahiti. Since three-fifths of the world's production of vanilla comes from the French colonies, the question of its culture is worthy of investigation. The fruit from Mexico and Reunion is superior to that of the Tahiti type. In the present note a comparison is made between the types of vanilla known under the names of Mexico, Tahiti, and Tiarei, and some practical suggestions are made for cultivation.—Paul **Vuillemin**: The staminal origin of the perigon of the Liliaceæ; proofs furnished by the flowers of Hemerocallis.—E. F. **Perreau**: An electro-vibrator worked with interrupted currents. Previous types of this instrument, used in surgical work, have been worked with an alternating current, but an interrupted continuous current may be also used with advantage. Details of the arrangement are given, which, for the detection of non-magnetic bodies, is superior to the original instrument.—Daniel **Berthelot**: The co-volume of the gases disengaged by explosive materials. The co-volume b, in the equation $p(v-b)=RT$, is usually taken as 0·001 in calculations relating to explosives. It is now shown that this only holds for gases the critical temperature of which is sensibly equal to four times the critical pressure.—M. **Guilbaud**: An apparatus for the photolysis of powders.—J. **Repelin**: The Cretaceous age (Begudian) of the detritic layers of Logis de Nans (Var).—Henry **Hubert**: Subterranean waters in western Africa. A chart of Senegal is given showing the depths of the underground water.—Jules **Amar**: Arthrodynamometric measurements. — H. **Vincent**: Typhoid toxin and the production of a specific serum against typhoid fever. A study of the conditions for obtaining cultures of high toxic power.

WASHINGTON, D.C.

National Academy of Sciences, August 15 (Proceedings No. 8, vol. i.).—J. **Loeb**: Weber's law and antagonistic salt action. The author had shown that the ratio of the concentrations of antagonistic ions must remain within certain limits for the normal functioning of an organism. It is here shown that these limits remain approximately constant as the concentration of one of the ions is changed.—E. L. **Nichols** and H. L. **Howes**: The polarised fluorescence of ammonium uranyl chloride. The remarkable fluorescence spectrum of this salt is described in considerable detail, observations being made at $+20°$ C. and $-185°$ C.—T. **Michelson**: The linguistic classification of Potawatomi. By study of the so-called verbal pronouns, which afford most satisfactory classificatory criteria, it is shown that Potawatomi belongs to the Ojibwa group of Central Algonquian dialects.—H. **Shapley** and Martha Betz **Shapley**: The light curve of XX. Cygni as a contribu- to the study of Cepheid variation. The form of the maximum of brightness in XX. Cygni is variable from period to period, and thus suggests the hypothesis that the periodic light and spectrum variations in this and other Cepheid variables should be ascribed to internal vibrations producing irregularities in luminosity instead of to double-star phenomena.—C. B. **Davenport**: The feebly inhibited. III.—Inheritance of temperament, with special reference to twins and suicides. A statistical study on eighty-nine family histories, affording 147 matings, leads to the conclusion that temperament is inherited as though there were in the germ plasm a factor E, which induces the more or less periodic occurrence of an excited condition and its absence, *e*, which results in a calmness; also a factor C which makes for normal cheerfulness and its absence, which permits a more or less periodic depression, the factors behaving as though in different chromosomes, so that they are inherited independently.—H. **Shapley**: Second-type stars of low mean density. Because of its bearing on the question of the order of stellar evolution, the density of stars of the second spectral type is discussed from the point of view of the dependability of the observational and theoretical work that is the basis of the derivation of occasional extremely low values.—W. H. **Brown** and Louise **Pearce**: The pathological action of arsenicals upon the adrenals. That arsenicals of diverse chemical constitution exert pronounced pathological action upon the adrenals has not been generally recognised. It appears from these observations that the adrenotropic action of arsenicals is one of the most constant and important features of arsenical intoxication, and it is suggested that therapeutic doses of some arsenicals may be found to produce definite stimulation of the adrenal glands.—Louise **Pearce** and W. H. **Brown**: Variations in the character and distribution of the renal lesions produced by compounds. Not all compounds of arsenic produce vascular lesions; some are capable of producing tubular nephritis; the difference in the pathogenic action being explainable only upon the basis of the chemical constitution of the different compounds of arsenic.—H. S. **White**: Seven points on a twisted cubic curve. If seven points on a twisted cubic be joined, two and two, by twenty-one lines, then any seven planes that contain these twenty-one lines will osculate a second cubic curve.

CAPE TOWN.

Royal Society of South Africa, July 21.—Dr. L. Péringuey, president, in the chair.—S. H. **Haughton**: Exhibition and description of a new type of fossil reptile from the Karroo. A somewhat incomplete skull, with associated limb-bones and vertebræ, from the upper Tapinocephalus zone of the Beaufort West District were exhibited. The form seems to show affinities both with the Dinocephalia and the Gorgonopsia. In the general form of the skull and of the palate it recalls the Dinocephalia, although it is much smaller, and its maxillary and premaxillary teeth are herbivorous, like those of Tapinocephalus and other forms; but in the possession of a few small palate teeth, in the vertical occipital plate, the shallowness of the basicranium and some other features it recalls the Gorgonopsia. The form occurs in beds which contain members of both groups, although the larger Dinocephalia of lower horizons seem to have given place to smaller forms. Watson has contended that these two groups have arisen from a not very far distant common ancestor; and although this form cannot be looked upon as ancestral, it throws some further light on the relationships between the two groups.—K. H. **Barnard**: Conus shells illustrating variation in markings. A series of shells was exhibited, showing gradation in the pigment from a condition in which the coloration is strongly marked to that in which the shells are practically colourless. The question of the origin of the pigment in its relation to the environment and heredity of the mollusc was discussed.—S. J. v. d. **Lingen**: (1) Simple apparatus for finding "G"; (2) simple apparatus for standardising a given vibrator. Apparatus was described the use of which does not involve assumptions of dynamical quantities that the student cannot determine for himself, and which is adapted to give him some definite idea about the acceleration of a freely falling body. A piece of apparatus was also described by which velocities and accelerations of trolleys, etc., can be determined without the need of assuming the

time of vibration of some vibrator.—J. K. E. **Halm**: Astronomical photometry. An account was given of a method which claims to derive from the measured diameters of the star discs on a photographic plate the brightness or "magnitude" of any star on a self-consistent basis. The work is founded on the examination of the properties of the photographic plate in the light of experiments made by Abney and Kron. The results obtained for the stars of the Cape astrographic zones demonstrate a perfect agreement of the Cape system with the Harvard photographic system. Comparisons between the photographic and visual magnitudes lead to the conclusion, also in agreement with the Harvard results, that the "colour" of the stars is a function of their brightness, faint stars being slightly redder than bright stars. This fact is tentatively attributed to the existence of absorbing matter in space. The phenomenon is emphasised in the regions of the galaxy. It is also found that, on the average, stars are actinically brighter in the Milky Way than in other regions. —W. A. **Jolly**: The electromotive changes accompanying activity in the mammalian ureter.—I. B. Pole **Evans**: A new aloe from Swaziland. A new species of aloe, found in Swaziland by Mr. R. A. Davis in June, 1914, was described and named *Aloe suprafoliata*. It may be recognised by its distichous leaves, which are rigid, somewhat fleshy, and patent or gracefully recurved. The flower spike is slender, unbranched, and bears rather loosely-attached rose doree flowers. The plants are usually found on the tops of quartzite kopjes, and have been found at Stegi, Lebombo Range, and Forbes Reef.

CALCUTTA.

Asiatic Society of Bengal, August 4.—S. C. **Mitra**: North Indian charms for securing immunity from the virus of scorpion-sting. Charms which are popularly supposed to render the user thereof either invulnerable to the stings of scorpions or immune from their virus, *e.g.*:—(1) By the repetition of certain passages of the Koran; (2) by performing the fire-walking ceremony known as *Dam madār;* and (3) by carrying about one's person the medicinal plant known as the *Chirchirā* (*Achyranthes aspera*). The author also described the preparation and discussed the origin of a curious cognate charm whereby a practitioner acquires the power to cure scorpion stings, after rubbing with his hands, while he is in a blindfolded state, the blossoms of a mango tree.—I. H. **Burkill**: The Terai Forests between the Gandak and the Tista.—Dr. N. **Annandale**: The origin and distribution of the fauna of the Lake Tiberias. The aquatic fauna of the Jordan river-system, and in particular that of the Lake of Tiberias, consists mainly of species belonging to Palæarctic genera, and closely allied to, if not identical with, forms from eastern Europe or from the Euphrates Valley. There are, however, a certain number of animals that are Ethiopian either in genus or species. It is a remarkable fact that the distinctly Ethiopian forms are all fish. There are a considerable number of endemic species in the Lake of Tiberias, but none of them are very highly specialised. The only endemic genus is the sponge Cortispongilla. The presence of African fish can only be explained by a former connection through the south of the system with the "Erythræan River" of Gregory, which received a tributary from Central Africa. The fish of African origin all belong to families and genera that are particularly suited to survive unfavourable conditions. The view is put forward that they have been able to survive great changes of salinity in the water of different parts of the Jordan system, while any African invertebrates that may have made their way into it have perished, with the possible exception of a few very widely distributed mollusca (such as *Melania tuberculata*) and other forms that exist in tropical Asia as well as in Africa.—S. C. **Banerji**: A botanical curio. A huge epiphytic *Ficus bengalensis*, L., on a tall *Borassus flabellifer*, L., is to be found in the village Barā on the way to Pāthrole from Madhupur (Sonthal Parganas). The two together appear to be a composite tree. One-half of the height of the palm from the ground, excepting a small portion at the base, is completely encased by the root of the fig. The persistence of the epiphytism is interesting.

BOOKS RECEIVED.

Canada. Department of Mines. Geological Survey. Memoir 69: Coal Fields of British Columbia. Compiled by D. B. Downing. Pp. iii+350. (Ottawa: Government Printing Bureau.)

Identification of Common Carbon Compounds. By J. N. Rakshit. Pp. iii+222. (Calcutta: *Collegian* Office.)

Applied Immunology. By Drs. B. A. Thomas and R. H. Ivy. Pp. xv+359. (Philadelphia and London: J. B. Lippincott Co.) 16s. net.

British Rainfall, 1914. By Dr. H. R. Mill and C. Salter. Pp. 448. (London: E. Stanford, Ltd.) 10s.

War Plants or Products of Intensive Kultur. By C. H. L. Woodhouse. Pp. 24. (London: G. Routledge and Sons, Ltd.) 6*d*. net.

The Hundred Best Animals. By L. Gask. Pp. 304. (London: G G. Harrap and Co.) 7*s*. 6*d*. net.

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THURSDAY, SEPTEMBER 9, 1915.

SOLAR MYTHS.

Sun Lore of All Ages. A Collection of Myths and Legends Concerning the Sun and Its Worship. By W. T. Olcott. Pp. xiii + 346. (New York and London: G. P. Putnam's Sons, 1914.) Price 10*s.* 6*d.* net.

IN the preface it is stated that the author, during the compilation of a volume on "Star Lore of All Ages," found a wealth of interesting material pertaining to the mythology and folk-lore of the sun which seemed worth putting together in a separate volume, including the legends, traditions and superstitions which all ages and nations have woven about the sun.

The author seems to have gathered his materials from a number of works on mythology and folk-lore, from which he frequently gives verbatim extracts. Outside this subject he does not appear to have made any special study of the general rise and progress of civilisation, as he sometimes makes curious mistakes. For instance, he tells us (p. 137) that Anaxagoras was put to death on account of his scientific opinions. But a worse fault is that no attempt is made to systematise the immense amount of legends and stories he has collected. The reader is repeatedly carried from India to North America, thence to Finland and *viâ* Greece to Scandinavia and back again. And the author has not avoided the snare in which so many students of folk-lore have been caught, by making simply every myth, fable or tale he has met with into a solar myth, from Jack-the-Giant-Killer to Jonah, Cain, the Homeric poems, and so *ad infinitum.* Needless to say, this process often involves very far-fetched explanations. Thus the Royal Arms of England, "supported by the solar lion and the lunar unicorn," are made to express solar worship. We do not quite know what to make of the following curious statement (p. 173):—

"The resemblance between the lives of the Sun-God Phœbus Apollo and Jesus Christ, the central figure and Exemplar of the Christian religion, is striking. The circumstances of their birth were in many respects similar, in that they were born in comparative obscurity. . . . For a while Phœbus Apollo hid his greatness in a beggar's garb. . . . This mode of existence was in every way similar to the life of Christ. . . . Although the Sun-God's death at nightfall is ignominious, akin in this respect to the crucifixion, still its predominant feature is one of glory, and the reappearance of the triumphant sun after death is in every way typical of the resurrection, thus portraying in a startling manner the completeness of the analogy between the lives of Christ and Apollo."

Has the author ever heard of Dupuis and his "Origine de tous les cultes"? Probably not, as he only quotes books written in the English language. But Dupuis in his voluminous work proved to his own satisfaction that the founder of the Christian religion had never existed: he was only a solar myth, identical with Bacchus, Osiris, and Hercules. It is safer to be cautious in drawing parallels between fact and fiction and in looking everywhere for solar myths. But all the same, even a critical reader will find much to interest him in the accounts of sun-worship and sun-myths given in this volume, not least in the numerous extracts from the publications of the United States Bureau of Ethnology. The book is beautifully illustrated with thirty plates taken from paintings or giving views of sun temples and worship.

POCKET ENCYCLOPÆDIAS OF PETROLEUM AND CHEMISTRY.

(1) *Petroleum Technologist's Pocket-Book.* By Sir Boverton Redwood, Bart., and Arthur W. Eastlake. Pp. xxiv + 454. (London: Charles Griffin and Co., Ltd., 1915.) Price 8*s.* 6*d.* net.

(2) *The Chemists' Year-Book,* 1915. Edited by F. W. Atack. Two vols. Vol. i., pp. 354. Vol. ii., pp. 355–914. (London and Manchester: Sherratt and Hughes, 1915.) Price 10*s.* 6*d.* net.

(1) THE names of Sir Boverton Redwood and Mr. Arthur W. Eastlake on the title-page of the "Petroleum Technologist's Pocket-Book" would alone be an ample guarantee that thoroughness of treatment and completeness of content would be found in its pages, and the work fully bears out the expectation arrived at. It is indeed a miniature edition of Sir Boverton Redwood's monumental work on petroleum, and in its 454 pages of pocket-book size contains more useful information, tables, and data referring to every branch of the mineral oil industry than it would be thought possible could be got into a portable form.

Starting with the origin and occurrence of petroleum in the earth's crust and its geographical distribution, prospecting for petroleum is next dealt with, and much useful information is given as to licences, mining leases, and regulations in various parts of the world.

Part ii. is geological, and contains definitions of various geological terms and the identification of rocks and strata illustrated in the coloured frontispiece of the succession of the stratified formations of the earth's crust. This part also contains many useful tables for horizons, angles of dip, natural sines, cosines, and tangents, quantities of oil per acre for given thicknesses of oil sand, and a host of other useful data.

Part iii. is chemical and physical, giving the specific gravities of crude oils, products, analyses, viscosity, calorific value, specific heat, and the composition of various purifying agents; whilst Part iv. treats of oil production in all its phases. Part v. embraces refining, transport, storage and testing of oils, and the next division goes fully into the uses of petroleum and its products. Part vii. is a mass of information on weights, measures, and other useful data connected with oil, whilst Parts viii. and ix. deal with miscellaneous information and statistics, brought down in most cases as late as 1913, and forming a fitting conclusion to a book which no one in any way interested in oil can afford to be without.

(2) Another extremely useful work is "The Chemists' Year-Book for 1915," compiled by Mr. F. W. Atack, of the Technical Department of Manchester University, and designed to take the place of the voluminous German publications, of which the English chemist has been forced to avail himself in the absence of any complete and up-to-date English collection of chemical data.

In order to secure portability it is published in two volumes—the first, a pocket-book containing a diary, all the more important details of qualitative, volumetric, gas, ultimate, electro-chemical and spectrum analysis, together with tables of the general properties of inorganic and organic substances, useful memoranda, conversion and logarithm tables.

The second volume, which from the absence of a flap is evidently intended more for reference, gives every possible table on the physical constants of gases, liquids, and solids, properties of minerals, and finally a really excellent summary of more technical processes, in which fuel and illuminants, acid and alkali manufacture, oils and fats, brewing, coal tar and its derivatives, synthetic dye-stuffs, and many other manufacturing processes find place.

It is refreshing to find, at a time when so much is being written and said as to the capture of German trade, that so practical a first step has been taken, and every working chemist will welcome this year-book, containing as it does in convenient form 900 pages of most useful data.

GEOGRAPHIC INFLUENCES AND THE OLD TESTAMENT.

Geographic Influences in Old Testament Masterpieces. By Prof. Laura H. Wild. Pp. xiii + 182. (Boston and London: Ginn and Co., 1915.) 4*s.* 6*d.*

THE book aims at showing how the physical environment and geographical conditions of a nation are expressed in its literature and history. This fact, notwithstanding its great importance, has been too often forgotten by teachers and perhaps in no case more frequently than in dealing with the older portion of the Bible. One cause of this has been a tendency, with a large section of the Christian church, to regard its older books with an unreasonable reverence, and forgetting that they are the history of a people, who, though the chosen means for imparting great truths to the world, were men and women like ourselves, even the best of whom were liable to human weaknesses. The authoress accordingly seeks to enhance the attractions of Bible teaching by linking its more interesting episodes with the main geographical features of the country—its coastal plain on the one side, and its inland desert on the other, its valleys and its hills —Carmel, Gilboa and Tabor, the cedar-clad slopes of Lebanon and the snowy dome of Hermon, from which the Jordan begins its course, in some respects unique, to its grave in the Salt Sea.

The intention of the book is excellent, but we cannot say so much for its execution. Prof. Laura Wild's comments seldom rise above the commonplace, and we find among them little or no evidence of a personal knowledge of Palestine. For descriptions of its scenery she seems to depend upon quotations from well-known travellers, so that we miss those little graphic touches which add to the life and interest of an account. To some statements also we must take exception, such as that Joseph was "little" when sold into Egypt, for he was over seventeen; that Heber can be described as an Israelite, and that Endor is near the Sea of Galilee. Her knowledge also of natural history and geology leaves something to be desired. It is misleading to call the cyclamen a native of Palestine, for the genus has a wide range, one species being claimed as British, which is at any rate common in many parts of Europe. The lion which Benaiah killed in a cave (he is not said to have been a boy, nor it to have contained snow) is not likely to have been a wanderer from the Jordan valley into the mountains of Judæa, for lions at one time were far from rare in Palestine, or even in Greece, while in prehistoric days they were common in Britain, when the climate was much colder than now.

The slopes of Pisgah, where Lot is said to have sought refuge in a cave, though they command a view of the Dead Sea, can scarcely have been subject to "volcanic storms of bitumen," which, by the way, is not usually an eruptive product. Whether it is "some thirty thousand years" since the last glacial period in Palestine may or may not be correct, but that was not indicated by the "earth's appearance above the sea," nor was the former unfit for men to live upon until "some five or six thousand years ago." "Sandstone, limestone and chalk," should probably be read "and shale," for chalk, in the strict sense of the word, is not found in Palestine. To say that the Jordan valley is not due to a "rift cut down into the rock by a flowing stream," but "to the original folding of the earth's crust," is both vague and inaccurate, and the peculiar physical features of the Kishon valley, which indirectly have so often made it a battlefield of nations, hardly receive even a passing notice. No doubt "geologically Palestine is a most interesting country with which to become acquainted," but we fear that this book will not do much to bring about so desirable a result.

OUR BOOKSHELF.

The Science of Mechanics: a Critical and Historical Account of its Development. By Prof. E. Mach. Supplement to the third English edition containing the author's additions to the seventh German edition. Translated and annotated by P. E. B. Jourdain. Pp. xiv+106. (Chicago and London: The Open Court Publishing Co., 1915.) Price 2*s.* 6*d.* net.

MACH completed the first edition of "The Science of Mechanics" at Prague in 1883. An English translation (by McCormack) appeared just ten years later, and of this two further editions embodying the alterations made in the successive German editions have been published.

With the seventh German edition (Leipzig, 1912), however, the alterations made were much more numerous and important; and the present volume, which forms a supplement to the third English edition (1907), contains a full account of them, together with some pages of notes due to the translator. It is remarkable that notwithstanding the thirty years which separate the first and seventh editions, Prof. Mach finds himself able to strike identically the same note in his new "conclusion" as he had done in the preface to the first edition. In that preface he undertook that "Mechanics will here be treated, not as a branch of mathematics, but as one of the physical sciences"; whilst in a concluding passage in the present volume he points out that "the doctrines of mechanics have developed out of the collected experiences of handicraft by an intellectual process of refinement . . . we see that the savage discoveries of bow and arrows, of the sling, and of the javelin, set up the most important law of modern dynamics—the law of inertia—long before it was misunderstood with thoroughgoing perversity by Aristotle and his learned commentators."

Mach speculates much as to the validity of the conceptions of absolute space and time, and on the effect of using as a reference system the "fixed" stars. What would have been the consequence had there existed a sufficiency of cosmic dust to render the stars invisible to an observer on the earth? In Mach's opinion the "surroundings in which we live, with their almost constant angles of direction to the fixed stars, appear to me to be an extremely special case, and I would not dare to conclude from this case to a very different one."

It is to be hoped that no library which possesses the third English edition will be without this companion volume.

Report on the Building and Ornamental Stones of Canada. Vol. ii., Maritime Provinces. By Dr. Wm. A. Parks. Pp. xii+264. Plates i–xlv, sketch maps 1–9. (Ottawa: Government Printing Bureau, 1914.)

THIS volume constitutes the third part of the monograph on the building and ornamental stones of Canada, and worthily upholds the high standard established in the earlier portion of the work. The greater part of this report is occupied by a systematic account of the quarries of the maritime provinces and of their products. The stones are considered according to the class to which they belong, *e.g.*, granite, black granite (greenstones), sandstone, limestone, &c., and arranged according to more or less definite geographical areas into which the quarries naturally fall. In order to give prominence to the economic and commercial aspect of the work, the quarries are described under the name of the owner wherever possible. The general plan adopted for the description of individual properties is: (*a*) quarry observations; (*b*) description of the stone, with tests; (*c*) economic remarks and statistics; (*d*) examples of the use of the stone. Sketch maps are given showing the geology and location of quarries in important districts; special mention must be made of the excellent colour-photo plates which show in an admirable manner the colour and appearance of the stones, a feature which should be appreciated by architects.

The Canadian Department of Mines is to be congratulated on the wisdom of undertaking a comprehensive and businesslike statement of the country's quarry resources, and not least, for carrying out a series of systematic tests on the quarry products. Whatever opinion may be held as to the value of such tests, there can be no doubt that when they are made under uniform conditions, and as nearly as possible at one time, their utility is enormously increased. The existence of this monograph should result in a great saving of time, energy, and money on the part of all users of stone in the Dominion.

J. A. H.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Probable Error of the Amplitudes in a Fourier Series obtained from a Given Set of Observations.

MR. DINES's question (NATURE, August 12, p. 644) as to the degree of significance to be attached to the amplitudes of waves of given period found in short series of observations and the likelihood of their permanence as the series is extended brings home again the reflection that whilst probable errors are easily found where the experience is large and they are least wanted, their determination from a limited experience where they would be most useful is largely hypothetical.

One of the principal sources of error springs from the process of selection. For example, we may find by counting that twelve persons out of twenty in an omnibus, picking up people at random, are males; but to predict from this the probable constitutions in like respect of other omnibuses, or to say that the percentage of males in London has been determined as sixty, with a probable error of 7·5, is clearly a misuse of statistical theory. The result is fallacious, because of the false premises. Omnibuses do not pick up people at random, or even travelling people at random. Persons go about in small groups, and there are larger groups going to the shopping centres and going citywards, and still larger groups travelling at the extreme hours and travelling at the mid hours of the day, and so on. The constitutions of the groups are different, and the probable error of the percentage is much in excess of that calculated on the basis of random sampling, this being due to a process which, applied to phenomena in general, may be called a tendency to cluster.

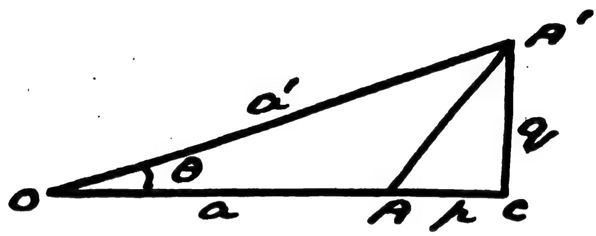
In all cases where a space or time content is taken as the sample it is necessary, owing to unknown clustering, to repeat the samples many times over, before a just estimate of the statistical constants and of their probable errors can be obtained.

Applied to meteorological and such-like phenomena, in which some value fluctuates in time, the successive observations are seldom at such a distance as to be haphazard, and the clustering, in this instance, is of the nature of waves similar to the waves which are the subject of observation. In these circumstances it does not seem possible, from observations of a single period, to make any estimate of the significance of an observed amplitude. This can only be done by repeating the period and noting the fluctuations in phase and amplitude found in such repetitions. If observations for many periods are to hand, then it is only following a well-understood practice to divide the material up into groups and calculate the constants of each group. From the fluctuations found in the several groups an empirical gauge of error may be constructed, upon which may be based a measure of error, suitable for application to the constant found for the whole.

If the phenomenon were one fully observed, and a frequency distribution of wave period and amplitude had been calculated by one of the several methods that have been proposed, then it would not be difficult to obtain the probability of error of any sustained wave found in the observations during a limited period of time. But such a frequency distribution is seldom a subject of research, although it is the first step in a description of the phenomenon, and one that cannot fail, by giving the salient periods, to mark out regions of investigation relative to the causes of undulation.

The more limited statement of the problem, as enunciated by Mr. Dines, renders it amenable to algebraical expression in the following manner.

A variable quantity has a periodic wave of amplitude a, and is subject, in addition, to casual fluctuations the mean of which is zero, and standard deviation σ. It is easily shown that if p and q are the amplitudes of the waves, phasal with, and in quadrature with, the above wave, calculated from the casual variations alone, the mean values of p and q are zero, and their standard deviations are $\sigma\sqrt{2}/\sqrt{n}$. Supposing that the distributions of p and q are normal, what will be the errors of the calculated amplitudes, and phase angles, due to these fluctuations?



Draw OA$=a$, AC$=p$, CA' at right angles$=q$.

Then, clearly, $a'=$OA' is the calculated amplitude due to p and q, superimposed upon a, and $\theta=$AOA' is the phase displacement.

Now A' has varying positions, due to the variations of p and q, and its frequency upon the element of area, dp, dq, about A', is that of a normal distribution, viz.:—

$$\frac{1}{\sqrt{(2\pi)}s} e^{-\frac{1}{2}p^2/s^2} dp \cdot \frac{1}{\sqrt{(2\pi)}s} e^{-\frac{1}{2}q^2/s^2} dq$$
$$= \frac{1}{2\pi s^2} e^{-\frac{1}{2}(p^2+q^2)/s^2} dp\, dq$$

where s is written for $\sigma\sqrt{2}/\sqrt{n}$, the *s.d.* of p or q.

Putting $p^2+q^2=\mathrm{AA'}^2=a'^2-2a'a\cos\theta+a^2$, and $dpdq=a'da'd\theta$, the variables are changed from p, q to a',θ, and the frequency distribution of a',θ *is* therefore

$$\int_0^\infty\int_0^{2\pi} \frac{1}{2\pi s^2} e^{-\frac{1}{2}(a'^2-2a'a\cos\theta+a^2)/s^2}\, a'da'd\theta.$$

When this is integrated with respect to θ the result will be the frequency distribution of amplitudes a'. It appears to be a problem of the nature of random migration, and the solution of the above integral will probably be found (I am unable to consult my reference) in Prof. Karl Pearson's memoir upon this subject.

If there is no initial wave, so that the calculated amplitudes are all due to casual fluctuations, then $a=0$ and the frequency distribution of a' becomes:—

$$\int_0^\infty \frac{1}{s^2} e^{-\frac{1}{2}a'^2/s^2}\, a'da'.$$

This is a well-known distribution, being, for instance, the distribution of arithmetical velocity of wind when the NS and EW components vary independently, in normal manner, with *s.d.* equal to s.

The mean is $\sqrt{(\frac{1}{2}\pi)}.s=1{\cdot}253s$, the standard deviation is $\sqrt{(2-\frac{1}{2}\pi)}.s=0{\cdot}655s$, and the number per cent. exceeding xs is $100\times e^{-\frac{1}{2}x^2}$.

Applying these formulæ to Mr. Dines's experimental data, the comparison of experiment with theory comes out as follows:—

Values of $a'=\surd(p^2+q^2)$. Mean p=mean q=0. *S.d.* of p=*s.d.* of q=10. 500 pairs taken.

	Experiment	Theory
Mean a'	12·5	12·53±0·20
Standard deviation of a' ...	6·5	6·55±0·14
Per cent. exceeding 25 ...	4·0	4·39±0·62

the agreement being very close in all three values.

Manchester. H. E. SOPER.

Antarctic Fossil Plants.

IT should have been stated that Prof. Seward's memoir (reviewed in NATURE for August 26) is the first dealing with the *geological* results of Capt. Scott's Expedition. Two numbers of the Zoological series had previously appeared—No. 1 of vol. i. on June 27, and No. 1 of vol. ii. on July 25, 1914.

D. H. S.

HENRY GWYN JEFFREYS MOSELEY.

SCIENTIFIC men of this country have viewed with mingled feelings of pride and apprehension the enlistment in the new armies of so many of our most promising young men of science —with pride for their ready and ungrudging response to their country's call, and with apprehension of irreparable losses to science. These forebodings have been only too promptly realised by the death in action at the Dardanelles, on August 10, of Henry Gwyn Jeffreys Moseley, 2nd Lieut. in the Royal Engineers, at the age of twenty-seven. A son of the distinguished zoologist, the late Prof. H. N. Moseley, of Oxford, he was educated at Eton, entering as a scholar, and passed to Trinity College, Oxford, where he gained a Millard Scholarship. He obtained a First Class in Mathematical Moderations, and Honours in Natural Science.

Moseley early showed marked originality and an enthusiatic interest in science. A year before his graduation he had decided to undertake original work in physics, and visited Manchester to discuss the matter with me. After graduation, he was appointed lecturer and demonstrator in the physics department of the University of Manchester, and immediately devoted all his spare time to investigation. After two years he resigned his lectureship in order to devote his energies entirely to research, and was awarded the John Harling Fellowship. During the past year he went to Oxford to live with his mother, and to continue his experiments in the laboratory of Prof. Townsend. He went out to Australia with the British Association, took an active part in the discussion on the "Structure of the Atom" at Melbourne, and gave an interesting account of his recent work on the X-ray spectra of the rare earths, in Sydney. On the outbreak of war he put aside all thought of continuing the investigations in which he was so vitally interested, and returned at once to England to offer his services to his country, and was granted a Commission in the Royal Engineers. He was later made signalling officer to the 38th Brigade of the First Army, and left for the Dardanelles on June 13. He took part in the severe fighting at the new landing on August 6 and 8, and was instantaneously killed on the 10th by a bullet through the head in the act of telephoning an order to his division at a moment when the Turks were attacking on the flank only 200 yards away.

Moseley was one of those rare examples of a man who was a born investigator. He rapidly acquired the technique of experiment and soon gained a remarkably wide and accurate knowledge of modern physics. His undoubted originality and marked capacity as an investigator were very soon ungrudgingly recognised by his co-workers in the laboratory, while his cheerfulness and willingness to help in all possible ways endeared him to all his colleagues. His first research, published in the Proceedings of the Royal Society, consisted in the determination of the average number of beta particles emitted during the transformation of an atom of radium B and radium C—a difficult and important piece of work. It then occurred to him to determine the potential to which radium could be charged in a high vacuum by the escape of its own beta particles. He was able to achieve such a high stage of exhaustion—and this before the advent of the molecular pump—that a small quantity of radioactive matter retained itself at a potential of more than 100,000 volts for several weeks. He devised an ingenious method for detecting the possible presence of very short-lived radioactive substances, and in conjunction with Fajans utilised the method to determine the period of transformation of a newly-discovered product in actinium, which was found to be half transformed in 1/500 of a second.

Moseley's interest was greatly aroused by the discovery of Laue of the diffraction of X-rays in their passage through crystals, and in conjunction with Mr. Charles Darwin he immediately started an investigation to examine the quantity and quality of the X-radiation scattered from crystals at different angles. Prof. Bragg, who was working simultaneously at Leeds on the same problem, observed the presence of definite maxima in the scattered radiation corresponding to definite lines in the X-ray spectrum. This result was confirmed and extended by Moseley and Darwin, and they mapped out accurately for the first time the spectrum of the characteristic X-radiation from an X-ray tube with a platinum antikathode. These pioneer investigations in Leeds and Manchester were of fundamental importance, for they laid the foundation of the new science of X-ray spectroscopy, which is now in the process of rapid development.

Moseley next decided to examine the X-ray spectra of a large number of different elements with the definite object of testing whether the spectrum was connected in a simple way with the atomic number of the element when arranged in increasing order of atomic weight. Suggestions had been previously made that the charge on the nucleus of an atom, which defines its chemical and physical properties, was possibly equal to the atomic number. For this purpose he developed the photographic method for accurate measure-

ments of the spectra. In his first paper he examined the spectra of a group of elements of atomic weight between calcium and zinc. He showed that a similar spectrum consisting of two strong lines was emitted by each of these elements, and proved that the frequency of the corresponding lines in the spectra was proportional to the square of a whole number which varied by unity in passing from one element to the next. This number, which was closely connected with the atomic number of the element, was considered to represent the nucleus charge. He next proceeded to make a systematic study of a great majority of the solid elements, and showed that a similar result held for them all. Since the frequency of a given line in the spectrum varied by definite jumps in passing from one element to the next, he was able to draw the deduction that there could only exist three unknown elements from aluminium to gold, and he was able to predict the atomic number and spectra of these missing elements. This new and powerful method of attack was of especial importance in connection with the much debated question of the number of the rare earth elements.

The fundamental importance of these discoveries was immediately recognised. Prof. Urbain came from Paris to Oxford in order to utilise Moseley's new method to decide the nature of the elements present in the numerous preparations he had made of the rare earths. The results of the investigation of the rare earths have not been published, but it is to be hoped that sufficient data will be available later.

Moseley's fame securely rests on this fine series of investigations, and his remarkable record of four brief years' investigation led those who knew him best to prophesy for him a brilliant scientific career. There can be no doubt that his proof that the properties of an element are defined by its atomic number is a discovery of great and far-reaching importance, both on the theoretical and the experimental side, and is likely to stand out as one of the great landmarks in the growth of our knowledge of the constitution of atoms.

It is a national tragedy that our military organisation at the start was so inelastic as to be unable, with few exceptions, to utilise the offers of services of our scientific men except as combatants in the firing line. Our regret for the untimely end of Moseley is all the more poignant that we cannot but recognise that his services would have been far more useful to his country in one of the numerous fields of scientific inquiry rendered necessary by the war than by exposure to the chances of a Turkish bullet.

E. RUTHERFORD.

THE BRITISH ASSOCIATION AT MANCHESTER.

WRITING on the eve of the British Association week, it may be said that the prospects of a good number of members and associates are much brighter now than they were a few weeks ago. The experiment of shortening the meeting and of cutting out of the programme the long-distance excursions was one that threatened to reduce the numbers considerably, but we can be assured now that a very large proportion of those who attend the meeting of the British Association are primarily attracted by the scientific programme.

The interest taken in the meeting by the citizens of Manchester and the surrounding district has very noticeably increased during the past week, and a large number of students and teachers are enrolling themselves as associates on the half-fee terms that were offered by the Council for this meeting.

The discussions that will probably attract the largest attendances from among the local members are those on industrial harmony in Section F and on military education in Section L. Mr. Balls's lecture on the application of science to the cotton industry in Section K will also attract a good audience of local people.

In addition to the afternoon sectional excursions already announced, the agriculturists have arranged visits to the Agricultural Institution of the Cheshire County Council at Holmes Chapel and to another large farm in the district.

The arrangements made by the local executive committee for the reception of the Association have now been completed, and it will be found that ample accommodation has been provided for the comfort and convenience of the visitors. In time of war there are some subjects that cannot be discussed advisedly in open section, particularly in the sections of the physical sciences; but it may be anticipated that some important work will be done in the private discussions of smaller groups of scientific men in the smoking and conversation rooms. The university and the high school for girls will between them provide facilities for such informal discussions on a larger scale, probably, than in any previous meeting of the Association.

INAUGURAL ADDRESS BY PROF. ARTHUR SCHUSTER, D.Sc., Sc.D., LL.D., DR.-ÈS-SC., F.R.S., PRESIDENT.

The Common Aims of Science and Humanity.

UNDER the influence of the diversity of pursuits imposed upon us by the conditions of modern life, different groups of the community—men of business, men of science, philosophers, or artists—have acquired detached and sometimes opposing interests. Each group, impressed by the importance of its own domain in the life of the nation, and focussing its vision on small differences and temporary rivalries, was in danger of losing the sense of mutual dependence. But in the shadow of a great catastrophe it has been brought home to us that the clash of interests is superficial, and the slender thread of union which remained has grown into a solid bond. What is the fibre from which the bond is twined? Patriotism may express its outward manifestation, but its staple is the mental relationship which remains continuous and dominant even in normal times, when each of us may peacefully go to earn his living and enjoy the course of his intellectual life.

Outwardly the community is divided into heterogeneous elements with mental attitudes cast in different moulds, and proceeding along separate roads

by differing methods to different ideals. Yet as we eliminate the superficial, and regard only the deep-seated emotions which control our thoughts and actions, the differences vanish, and the unity of purpose and sentiment emerges more and more strongly. Mind and character, no doubt, group themselves into a number of types, but the cleavage runs across, and not along, the separating line of professions.

Were it otherwise, the British Association could not perform one of its most important functions—a function not, indeed, originally contemplated, but resulting indirectly from the wise and democratic provisions in its constitution, which enabled it to adapt itself to the changing needs of the time. Our founders primarily considered the interests of scientific men; their outlook was restricted and exclusive, both as regards range of subject and membership. In the words of Sir David Brewster, who gave the first impulse to its formation, it was to be "an association of our nobility, clergy, gentry, and philosophers."

The meetings were intended to promote personal intercourse, to organise research, to advocate reform of the laws hindering research, and to improve the status of scientific men. The right of membership was confined to those who already belonged to some learned society, and William Whewell, one of the principal supporters of the movement, even suggested that only authors of memoirs published by a learned society should be admitted.[1] He emphasised this proposal by the recommendation[2] "in some way to avoid the crowd of lay members whose names stand on the List of the Royal Society." The reform of the Patent Laws and the introduction of an International Copyright were suggested as subjects suitable for discussion, not apparently from the point of view of general advantage, but merely in the interests of one section of the community.

Whatever the objects of the founders of the association may have been, it is obvious that questions of public importance could not be permanently excluded from meetings the success of which depended on the interest stimulated in the community. The Statistical Section, which owed its origin to the visit, at the first Oxford meeting (1836), of Quetelet, the Belgian astronomer and economist, was the first to assert itself by engaging in a discussion of the Poor Laws. Whewell deeply resented this violation of academic neutrality: "it was impossible," he wrote, "to listen to the Proceedings of the Statistical Section on Friday without perceiving that they involved exactly what it was most necessary and most desired to exclude from our Proceedings,"[3] and again: "Who would propose (I put it to Chalmers, and he allowed the proposal to be intolerable) an ambulatory body, composed partly of men of reputation and partly of a miscellaneous crowd, to go round year by year from town to town and at each place to discuss the most inflammatory and agitating questions of the day?"[4]

Fortunately for our association, this narrow-minded attitude did not prevail, and our records show that while not avoiding controversial and even inflammatory subjects, we have been able to exercise a powerful influence on the progress of science. The establishment of electric units, universally accepted throughout the world, originated in the work of one of our committees; the efforts which led to the foundation of the National Physical Laboratory, one of the most efficient and beneficial organisations in the country, received its first impulses from us; and the organisation of the first world service for the systematic investigation of earth tremors was established by the late Dr. Milne, working through one of our committees.

The success of these enterprises alone is sufficient to show that we are not merely a body promoting social intercourse between men of science and the rest of the community. Nevertheless, it may be admitted that our efforts have been spasmodic, and the time has arrived to consider whether it may be possible to secure not only a greater continuity in our work but also its better co-ordination with that of other scientific organisations. The present juncture affords the opportunity, and the changed conditions, which in the near future will affect all our institutions, render it indeed incumbent upon us once more to adapt ourselves to the needs of the times. Proposals for a move in that direction have already been made, and will no doubt be carefully considered by the council. In the meantime, I may direct your attention to the important discussions arranged for by our Economic Section, which alone will justify the decision of the council not to suspend the meeting this year.

It must not be supposed that, even in the early days of the association, Whewell's ideas of its functions were universally accepted. It is pleasant to contrast the lamentations of the omniscient professor of mineralogy with the weightier opinion of the distinguished mathematician who then held Newton's chair at Cambridge. At the concluding session of the second meeting of the association, Babbage expressed the hope "that in the selection of the places at which the annual meetings were to be held, attention should be paid to the object of bringing theoretical science in contact with the practical knowledge on which the wealth of the country depends." "I was myself," he said, "particularly anxious for this, owing as I do a debt of gratitude for the valuable information which I have received in many of the manufacturing districts, where I have learned to appreciate still more highly than before the value of those speculative pursuits which we follow in our academical labours. I was one of those who thought at first that we ought to adjourn for our next meeting to some larger manufacturing town; but I am now satisfied that the arrangement which has been made will be best adapted to the present state of the association. When, however, it shall be completely consolidated I trust we may be enabled to cultivate with the commercial interests of the country that close acquaintance which I am confident will be highly advantgeous to our more abstract pursuits."

Since then, as we all know, our most successful meetings have been held in manufacturing centres; but it should be observed that, while Babbage laid stress on the benefit which would accrue to pure science by being brought into contact with practical life, scientific men of the present day have more and more insisted on the services they, on their part, are able to render to the industries. The idealistic motive has thus given way to the materialistic purpose. Both aspects are perhaps equally important, but it is necessary to insist, at the present time, that the utilitarian drum can be beaten too loudly. There is more than one point of contact between different activities of the human mind, such as find expression in scientific pursuits or commercial enterprises, and it is wrong to base the advantages to be derived from their mutual influence solely, or even mainly, on the ground of material benefits.

I need not press this point in a city which has given many proofs that a business community may be prompted by higher motives than those which affect their pockets. It was not for utilitarian objects that

[1] Others were allowed to join on recommendation by the General Committee. It was only in 1906 that this restriction, which had become obsolete, was removed.

[2] "Whewell's Writings and Letters," vol. ii., p. 128.

[3] *Loc. cit.*, p. 289.

[4] It is much to be desired that the documents relating to the early history of the British Association should be published in a collected form.

repeated efforts were made since the year 1640 to establish a University in Manchester; it was not for reasons of material gain that the Royal Institution and Owens College were founded; nor was it because they increased the wealth of the district that the place of honour in our Town Hall has been given to Dalton and Joule.

When we glance at the various occupations of the working parts of a nation, comprising the student who accumulates or extends knowledge, the engineer who applies that knowledge, the geologist or agriculturist who discloses the store of wealth hidden in the soil, the commercial man who distributes that wealth, it seems as if we ought to be able to name the qualities of intellect and temperament which in each pursuit are most needed to carry out the work successfully. But on trying to define these qualities we soon discover the formidable nature of the task. Reasoning power, inventive power, and sound balance of judgment are essential attributes in all cases, and the problem is reduced to the question whether there are different varieties of the attributes which can be assigned to the different occupations.

Among all subjects mathematics is perhaps the one that appears most definitely to require a special and uncommon faculty. Yet, Poincaré—himself one of the clearest thinkers and most brilliant exponents of the subject—almost failed when he attempted to fix the distinguishing intellectual quality of the mathematician. Starting from the incontrovertible proposition that there is only one kind of correct reasoning, which is logical reasoning, he raises the question why it is that everybody who is capable of reasoning correctly is not also a mathematician, and he is led to the conclusion that the characterising feature is a peculiar type of memory. It is not a better memory, for some mathematicians are very forgetful, and many of them cannot add a column of figures correctly; but it is a memory which fixes the order in which the successive steps of reasoning follow each other without necessarily retaining the details of the individual steps. This Poincaré illustrates by contrasting the memory of a chess-player with that of a mathematician. "When I play chess," he says, "I reason out correctly that if I were to make a certain move, I should expose myself to a certain danger. I should, therefore, consider a number of other moves, and, after rejecting each of them in turn, I should end by making the one which I first contemplated and dismissed, having forgotten in the meantime the ground on which I had abandoned it." "Why, then," he continues, "does my memory not fail me in a difficult mathematical reasoning in which the majority of chess-players would be entirely lost? It is because a mathematical demonstration is not a juxtaposition of syllogisms, but consists of syllogisms placed in a certain order; and the order in which its elements are placed is much more important than the elements themselves. If I have this intuition—so to speak—of the order, so as to perceive at one glance the whole of the reasoning, I need not fear to forget its elements: each of these will take its right place of its own accord without making any call on my memory."[5]

Poincaré next discusses the nature of the intellectual gift distinguishing those who can enrich knowledge with new and fertile ideas of discovery. Mathematical invention, according to him, does not consist in forming new combinations of known mathematical entities, because the number of combinations one could form are infinite, and most of them would possess no interest whatever. Inventing consists, on the contrary, in excluding useless combinations, and therefore:—"To invent is to select—to choose. . . . The expression 'choose' perhaps requires qualifying, because it recalls a buyer to whom one offers a large number of samples which he examines before making his choice. In our case the samples would be so numerous that a lifetime would not suffice to complete the examination. That is not the way things are done. The sterile combinations never present themselves to the mind of the inventor, and even those which momentarily enter his consciousness, only to be rejected, partake something of the character of useful combinations. The inventor is therefore to be compared with an examiner who has only to deal with candidates who have already passed a previous test of competence."

All those who have attempted to add something to knowledge must recognise that there is a profound truth in these remarks. New ideas may float across our consciousness, but, selecting the wrong ones for more detailed study, we waste our time fruitlessly. We are bewildered by the multitude of roads which open out before us, and, like Poincaré when he tries to play chess, lose the game because we make the wrong move. Do we not all remember how, after the announcement of a new fact or generalisation, there are always many who claim to have had, and perhaps vaguely expressed, the same idea? They put it down to bad luck that they have not pursued it, but they have failed precisely in what, according to Poincaré, is the essence of inventive power. It may be bad luck not to have had a good idea, but to have had it and failed to appreciate its importance is downright incapacity.

An objection may be raised that before a selection can be made the ideas themselves must appear, and that, even should they arrive in sufficient numbers, the right one may not be among them. It may even be argued that Poincaré gives his case away by saying that "the sterile combinations do not even present themselves to the mind of the inventor," expressing in a negative form what may be the essence of the matter. Moreover, a fertile mind like that of Poincaré would be apt to place too low a value on his own exceptional gifts. Nevertheless, if Poincaré's more detailed exposition be read attentively, and more especially the description of how the discoveries which made him famous among mathematicians originated in his mind, it will be found that his judgment is well considered and should not be lightly set aside. New ideas seldom are born out of nothing. They most frequently are based on analogies, or the recollection of a sequence of thoughts suggested by a different branch of the subject, or perhaps by a different subject altogether. It is here that the memory comes in, which is not a memory of detail, but a memory of premises with their conclusions, detached from the particular case to which they were originally applied. Before we pronounce an adverse opinion on Poincaré's judgment, we must investigate what constitutes novelty in a new idea; but the subject is too vast to be dealt with here, nor can I attempt to discuss whether an essential distinction exists between mathematical invention and that more practical form of invention with which, for instance, the engineer has to deal.

If Poincaré, by this introspective analysis of his own powers, has dimmed the aureole which, in the eyes of the public, surrounds the mathematician's head, he removes it altogether by his definition of mathematics. According to him, "mathematics is the art of calling two different things by the same name." It would take me too far were I to try to explain the deep truth expressed in this apparently flippant form: physicists, at any rate, will remember the revolution created in the fundamental outlook of science by the application of the term "energy" to

[5] "Science et Méthode," pp. 46 and 47.

the two quite distinct conceptions involved in its subdivisions into potential and kinetic energy.

Enough has been said to show that the peculiar powers necessary for the study of one of the most abstruse branches of knowledge may be expressed in terms which bring them down to the level at which comparison with other subjects is possible. Applying the same reasoning to other occupations, the same conclusion is inevitable. The commercial man, the politician, and the artist must all possess the type of memory best suited to concentrate in the field of mental vision their own experiences as well as what they have learned from the experience of others; and, further, they must have the power of selecting out of a multitude of possible lines of action the one that leads to success; it is this power which Poincaré calls the inventive faculty.

The argument must not be pushed too far, as it would be absurd to affirm that all differences in the capability of dealing successfully with the peculiar problems that occur in the various professions may be reduced to peculiarities of memory. I do not even wish to assert that Poincaré's conclusions should be accepted without qualification in the special case discussed by him. What is essential, to my mind, is to treat the question seriously, and to dismiss the vague generalities which, by drawing an artificial barrier between different groups of professions, try to cure real or imaginary defects through plausible though quite illusory remedies. All these recommendations are based on the fallacy that special gifts are associated with different occupations. Sometimes we are recommended to hand over the affairs of the nation to men of business; sometimes we are told that salvation can only be found in scientific methods—what is a man of business, and what is a scientific method? If you define a man of business to be one capable of managing large and complicated transactions, the inference becomes self-evident; but if it be asserted that only the specialised training in commercial transactions can develop the requisite faculties, the only proof of the claim that could be valid would be the one that would show that the great majority of successful statesmen, or political leaders, owed their success to their commercial experience. On the other hand, every method that leads to a correct result must be called a scientific method, and what requires substantiating is that scientific training is better than other training for discovering the correct method. This proof, as well as the other, has not been, and, I think, cannot be, given. When, therefore, one man calls for the conduct of affairs "on business lines" and the other clamours for scientific methods, they either want the same thing or they talk nonsense. The weak point of these assertions contrasting different classes of human efforts is that each class selects its own strongest men for comparison with the weakest on the other side. Where technical knowledge is required, the specialist should be consulted, but in questions of general policy he is seldom the best judge.

The most fatal distinction that can be made is the one which brings men of theory into opposition to men of practice, without regard to the obvious truth that nothing of value is ever done which does not involve both theory and practice; while theory is sometimes overbearing and irritating, there are among those who jeer at it some to whom Disraeli's definition applies: the practical man is the man who practises the errors of his forefathers. With refined cruelty Nemesis infects us with the disease most nearly akin to that which it pleases us to detect in others. It is the most dogmatic of dogmatics who tirades against dogma, and only the most hopeless of theorists can declare that a thing may be right in theory and wrong in practice.

Why does a theory ever fail, though it may be sound in reasoning? It can only do so because every problem involves a much larger number of conditions than those which the investigator can take into account. He therefore rejects those which he believes to be unessential, and if his judgment is at fault he goes wrong. But the practical man will often fail for the same reason. When not supported by theoretical knowledge he generalises the result of an observation or experiment, applying it to cases where the result is determined by an altogether different set of conditions. To be infallible the theorist would have to take account of an infinite number of circumstances, and his calculations would become unmanageable, while the experimenter would have to perform an infinite number of experiments, and both would only be able to draw correct conclusions after an infinite lapse of time. They have to trust their intuition in selecting what can be omitted with impunity, and, if they fail, it is mainly due to the same defect of judgment. And so it is in all professions: failure results from the omission of essential considerations which change the venue of the problem.

Though theory and practice can only come into opposition when one of them is at fault, there is undoubtedly a contrast in character and temperament between those who incline more towards the one and those who prefer the other aspect; some like a solitary life at the desk, while others enjoy being brought into contact with their fellows. There have at all times been men predestined by nature to be leaders, and leadership is required in all branches of knowledge—the theoretical as well as the more active pursuits; but we must guard against accepting a man's estimate of his own power to convert his thoughts into acts. In the ordinary affairs of life a man who calls himself a man of action is frequently only one who cannot give any reasons for his actions. To claim that title justly a man must act deliberately, have confidence in his own judgment, sufficient tenacity of purpose to carry it through, and sufficient courage to run the unavoidable risks of possible failure. These risks may be trivial or they may be all-important. They may affect the reputation of one unit of creation or involve the whole life of a nation, and according to the greatness of the issue we shall honour the man who, having taken the risk, succeeds. But whether the scale be microscopic or interstellar, the essence of the faculty of blending theory and practice is the same, and both men of books and men of action are to be found in the philosopher's study and the laboratory, as well as in the workshop or on the battlefield. Modern science began, not at the date of this or that discovery, but on the day that Galileo decided to publish his Dialogues in the language of his nation. This was a deliberate act destined to change the whole aspect of science which, ceasing to be the occupation of a privileged class, became the property of the community. Can you, therefore, deny the claim of being a man of action to Galileo, can you deny it to Pasteur, Kelvin, Lister, and a host of others? There are, no doubt, philosophers who cannot manage even their own affairs, and whom it would be correct to call pure theorists, but that proves nothing, because their defect makes them worse philosophers as well as worse citizens.

In his presidential address, delivered to this Association in 1899, Sir Michael Foster summarised the essential features of the scientific mind. Above all other things he considered that its nature should be such as to vibrate in unison with what it is in search of; further, it must possess alertness, and

finally moral courage. Yet after enumerating these qualities, he arrives at the same result which I have tried to place before you, that there are no special peculiarities inherent in the scientific mind, and he expresses this conclusion in the following words:—

"But, I hear someone say, these qualities are not the peculiar attributes of the man of science, they may be recognised as belonging to almost everyone who has commanded or deserved success, whatever may have been his walk in life. That is so. That is exactly what I would desire to insist, that the men of science have no peculiar virtues, no special powers. They are ordinary men, their characters are common, even commonplace. Science, as Huxley said, is organised common-sense, and men of science are common men drilled in the ways of common-sense."

This saying of Huxley's has been repeated so often that one almost wishes it were true, but unfortunately I cannot find a definition of common-sense that fits the phrase. Sometimes the word is used as if it were identical with *uncommon* sense, sometimes as if it were the same thing as common *nonsense*. Often it means untrained intelligence, and in its best aspect it is, I think, that faculty which recognises that the obvious solution of a problem is frequently the right one. When, for instance, I see, during a total solar eclipse, red flames shooting out from the edge of the sun, the obvious explanation is that these are real phenomena caused by masses of glowing vapours ejected from the sun; and when a learned friend tells me that all this is an optical illusion due to anomalous refraction, I object on the ground that the explanation violates my common-sense. He replies by giving me the reasons which have led him to his conclusions, and, though I still believe that I am right, I have to meet him with a more substantial reply than an appeal to my own convictions. Against a solid argument common-sense has no power and must remain a useful but fallible guide which both leads and misleads all classes of the community alike.[6]

If we must avoid assuming special intellectual qualities when we speak of groups of men within one country, we ought to be doubly careful not to do so without good reason in comparing different nations. So-called national characteristics are in many cases matters of education and training; and, if I select one as an example, it is because it figures so largely in public discussions at the present moment. I refer to that expedient for combining individual efforts which goes by the name of organisation. An efficient organisation requires a head that directs and a body that obeys; it works mainly through discipline, which is its most essential attribute. Every institution, every factory, every business establishment is a complicated organism, and no country ever came to prominence in any walk of life unless it possessed the ability to provide for the efficient working of such organisms. To say that a nation which has acquired and maintained an empire, and which conducts a large trade in every part of the world, is deficient in organising power is therefore an absurdity. Much of the current self-depreciation in this respect is due to the confusion of what constitutes a true organisation with that modification of it which to a great extent casts aside discipline and substitutes co-operation. Though much may be accomplished by co-operation, it is full of danger in an emergency, for it can only work if it be loyally adhered to; otherwise it resembles a six-cylinder motor in which every sparking-plug is allowed to fix its own time of firing. Things go well so long as the plugs agree; but there is nearly always one among them that persists in taking an independent course and, when the machine stops, complains that the driver is inefficient. The cry for organisation, justifiable as it no doubt often is, resolves itself, therefore, into a cry for increased discipline, by which I do not mean the discipline enforced at the point of the bayonet, but that voluntarily accepted by the individual who subordinates his own convictions to the will of a properly constituted authority.

This discipline is not an inborn quality which belongs more to one nation than to another; it is acquired by education and training. In an emergency, it is essential to success, but if it be made the guiding principle of a nation's activity, it carries dangers with it which are greater than the benefits conferred by the increased facility for advance in some directions.

If there be no fundamental difference in the mental qualifications which lead to success in our different occupations, there is also none in the ideals which move us in childhood, maintain us through the difficulties of our manhood, and give us peace in old age. I am not speaking now of those ideals which may simultaneously incite a whole nation to combined action through religious fervour or ambition of power, but I am speaking of those more individual ideals which make us choose our professions and give us pleasure in the performance of our duties.

Why does a scientific man find satisfaction in studying Nature?

Let me once more quote Poincaré[7]:—

"The student does not study Nature because that study is useful, but because it gives him pleasure, and it gives him pleasure because Nature is beautiful; if it were not beautiful it would not be worth knowing and life would not be worth living. I am not speaking, be it understood, of the beauty of its outward appearance—not that I despise it, far from it, but it has nothing to do with science: I mean that more intimate beauty which depends on the harmony in the order of the component parts of Nature. This is the beauty which a pure intelligence can appreciate and which gives substance and form to the scintillating impressions that charm our senses. Without this intellectual support the beauty of the fugitive dreams inspired by sensual impressions could only be imperfect, because it would be indecisive and always vanishing. It is this intellectual and self-sufficing beauty, perhaps more than the future welfare of humanity, that impels the scientific man to condemn himself to long and tedious studies. And the same search for the sense of harmony in the world leads us to select the facts in Nature which can most suitably enhance it, just as the artist chooses among the features of his model those that make the portrait and give it character and life. There need be no fear that this instinctive and unconscious motive should tempt the man of science away from the truth, for the real world is far more beautiful than any vision of his dreams. The greatest artists that ever lived—the Greeks—constructed a heaven, yet how paltry that heaven is compared to ours! And it is because simplicity and grandeur are beautiful that we select by preference the simplest and grandest facts, and find our highest pleasure, sometimes in following the gigantic orbits of the stars, sometimes in the microscopic study of that minuteness which also is a grandeur, and sometimes in piercing the secrets of geological times which attract us because they are remote. And we see that the cult of the beautiful guides us to the same goal as the study of the useful."

[6] Since writing the above, I find on reading Prof. J. A. Thomson's "Introduction to Science" a similar criticism of Huxley's dictum. Prof. Thomson's general conclusions are not, however, in agreement with those here advocated.

[7] *Loc. cit.*, p. 15.

"Whence comes this harmony? Is it that things that appear to us as beautiful are simply those which adapt themselves best to our intelligence, and are therefore the tools which that intelligence handles most easily; or is it all the play of evolution and natural selection? In that case, those races only survived whose ideals best conformed with their interests, and while all nations pursued their ideals without regard to consequences, some were led to perdition and others achieved an empire. One is tempted to believe that such has been the course of history, and that the Greeks triumphed over the barbarians, and Europe, inheritor of Greek thought, rules the world, because the savages cared only for the sensual enjoyment of garish colours and the blatant noise of the drum, while the Greeks loved the intellectual beauty which is hidden beneath the visible beauty. It is that higher beauty which produces a clear and strong intelligence." If the mathematician's imagination is fired by the beauty and symmetry of his methods, if the moving spring of his action is identical with that of the artist, how much truer is this of the man of science who tries by well-designed experiments to reveal the hidden harmonies of Nature? Nor would it be difficult, I think, to trace the gratification inherent in the successful accomplishments of other intellectual pursuits to the same source.

Though Poincaré was, I believe, the first to lay stress on the connection between the search for the beautiful and the achievement of the useful, the æsthetic value of the study of science had previously been pointed out, and well illustrated, by Karl Pearson in his "Grammar of Science." As expressed by him: "It is this continual gratification of the æsthetic judgment which is one of the chief delights of pure science." Before we advance, however, any special claim for the pursuit of science based on these considerations, we must pause to think whether they do not equally apply to other studies or occupations. For this purpose, the nature of the æsthetic enjoyment involved must be remembered. We do not mean by it, the pleasure we feel in the mere contemplation of an impressive landscape or natural beauty, but it resembles more the enjoyment experienced on looking at a picture where, apart from the sensual pleasure we are affected by the relation between the result of the representation and that which is represented. The picture, quite apart from what it may be trying to imitate, has a certain beauty due to its contrast of colours or well-balanced arrangement. We have in one case a number of pigments covering a space of two dimensions, and in the other the natural object in three dimensions made up of entirely different materials and showing an infinite variety of detail and appearance. By itself alone either a mere photographic representation, or a geometrical arrangement of colour and line, leaves most of us cold; though both have their own particular beauty, the art consists in bringing them into connection. Bearing in mind the æsthetic value of the relationship of the work of our brain or hand to external facts or appearances, it might easily be shown that what has been said of science equally applies to other studies, such as history or literature. We may even go further, and say that any occupation whatever, from which we can derive an intellectual pleasure, must possess to a greater or smaller degree the elements of combining the useful with the beautiful.

In order to trace in detail the part played by purely emotional instincts in directing the course of our lives, we should have to study the causes which influence a child, free to select his future profession. Having eliminated secondary efforts, such as early associations, or the personal influence of an inspiring teacher, we should probably be brought to a standstill by the dearth of material at our disposal, or led into error by taking our own individual recollections as typical. Nevertheless it is only through the record of each man's experience that we may hope to arrive at a result. If every man who has reached a certain recognised position in his own subject—it need not be pre-eminence—would write down his own recollections of what led him to make the choice of his profession, we might hope to obtain facts on which a useful psychological study might be based. Scientific men as a class are not modest, but they share with other classes the reluctance to speak of their early life, owing to a certain shyness to disclose early ambitions which have not been realised. It requires courage to overcome that shyness, but I think that we need feel no shame in revealing the dreams of our childhood and holding fast to them despite the bondage of our weakness, despite the strife ending so often in defeat, despite all the obstacles which the struggle for existence has placed in our path. In some form they should persist throughout our lives and sustain us in our old age.

But the account of our early life should be simple, detached from any motives of self-depreciation or self-assertion, and free from any desire to push any particular moral or psychological theory. We want to trace the dawn of ambition, the first glimmering in the child's mind that there is something that he can do better than his fellows and reminiscences of early likes and dislikes which, though apparently disconnected from maturer tendencies, may serve as indications of a deep-seated purpose in life. It may be difficult to resist the temptation of trying to justify one's reputation in the eyes of the world; but it is worth making the effort. The only example that I know of such an autobiographical sketch is that of Darwin, which is contained in his "Life and Letters," published by his son, Sir Francis Darwin.

The ambition of a child to be better, cleverer, or more beautiful than its fellows is in the main, I think, a wish to please and to be praised. As the child grows up, the ambition becomes more definite. It is not a sordid ambition for ultimate wealth or power, nor is it an altruistic ambition to do good for the sake of doing good. Occasionally it takes the form confessed to by Darwin, when he says: "As a child I was much given to inventing deliberate falsehoods, and this was always done for the sake of causing excitement." This desire to be conspicuous was, in Darwin's case, consistent with extreme modesty, amounting almost to a want of confidence in himself, as appears in this passage: "I remember one of my sporting friends, Turner, who saw me at work with my beetles, saying that I should some day be a Fellow of the Royal Society, and this notion seemed to me to be preposterous."

We next come to the stage where a child is attracted by one subject more than another, and, if his choice be free, will select it for his life's career. What guides him in this choice? If it be said that a boy gravitates towards that subject which he finds easiest, we are led to the further question, why does he find it easiest? It is on this point that more information is required, but I am inclined to answer in accordance with Poincaré's views that it is because its particular beauty appeals most strongly to his emotional senses. In questions of this kind everyone must form his own conclusions according to his personal recollections, and these convince me that the emotional factor appears already at an early age. It is the strong attraction towards particular forms of reasoning, more perhaps even than the facility with which reasoning comes, that carries us over the initial

difficulties and the drudgery that must accompany every serious study.

I have already alluded to the different tendencies of individuals either to prefer solitary reflection or to seek companionship. Almost in every profession we find men of both types. Darwin's autobiography furnishes a good example of the man who prefers to learn through quiet reading rather than through lectures, but to many men of science the spoken word is inspiring and contact with congenial minds almost a necessity.

From our present point of view the most interesting passages in Darwin's autobiography are those indicating the æsthetic feeling which, like Poincaré, he connects with scientific research. Referring to his early studies we find this passage: "I was taught by a private tutor, and I distinctly remember the intense satisfaction which the clear geometrical proofs gave me. I remember with equal distinctness the delight which my uncle gave me by explaining the principle of the vernier of a barometer." To a man who apparently had no pronounced facility of mastering mathematical difficulties this feeling of satisfaction is especially remarkable. The combination of scientific ability with leanings either to music, or art, or poetry, is very common, and examples are to be found in almost every biography of men of science. It is difficult indeed to name an eminent scientific man who has not strong leanings towards some artistic recreation: we find the poetic vein in Maxwell and Sylvester, the musical talent in Helmholtz and Rayleigh, and the enthusiastic though amateurish pictorial efforts of less important men. That the similarities are to be found also in temperament may be noticed on reading Arnold Bennett's article on "The Artist and the Public,"[8] where many passages will be seen to be applicable to students of science as well as to writers of fiction.

If we look for distinctions between different individuals, we may find one in their leanings either towards the larger aspects of a question or the microscopic study of detail. The power of focussing simultaneously the wider view and the minute observation is perhaps the most characteristic attribute of those who reach the highest eminence in any profession, but the great majority of men have a notable predilection for the one or other side. Though it is indispensable for a scientific man to study the details of the particular problem he is trying to solve, there are many who will lose interest in it as soon as they believe they can see a clear way through the difficulties without following up their solution to its utmost limits. To them detail, as such, has no interest, and they will open and shut a door a hundred times a day without being even tempted to inquire into the inner working of the lock and latch.

There is only one feature in the operation of the intelligence by means of which a sharp division may possibly be drawn between brain-workers showing special capabilities in different subjects. In some persons thought attaches itself mainly to language, in others to visualised images, and herein lies perhaps the distinction between the literary and scientific gift. Those who, owing to external circumstances, have resided in different countries are sometimes asked in what language they think. Speaking for myself, I have always been obliged to answer that, so far as I can tell, thought is not connected with any language at all. The planning of an experiment or even the critical examination of a theory is to me entirely a matter of mental imagery, and hence the experience, which I think many scientific men must have shared, that the conversion of thought into language, which is necessary when we wish to communicate its results to others, presents not only the ordinary difficulties of translation, but reveals faults in the perfection or sequence of the images. Only when the logic of words finally coincides with the logic of images do we attain that feeling of confidence which makes us certain that our results are correct.

A more detailed examination of the instinctive predilections of a child would, I think, confirm Poincaré's conclusion that a decided preference for one subject is in the main due to an unconscious appeal to his emotions. It should be remembered, however, that the second step of Poincaré's philosophy is as important as the first. The mere emotional impulse would die out quickly, if it were not supplemented by the gratification experienced on discovering that the search for the beautiful leads us to results which satisfy our intellect as well as our emotions. There may still be bifurcations in the second portion of the road. Some may rest content with achieving something that supplies the material needs of humanity, others may be inspired to search for the deeper meaning of our existence.

There remains, therefore, some justification for the question why we persist in studying science apart from the mere intellectual pleasure it gives us. It was once a popular fallacy to assume that the laws of nature constituted an explanation of the phenomena to which they applied, and people then attached importance to the belief that we could gauge the mind of the Creator by means of the laws which govern the material world, just as we might trace the purpose of a human legislator in an Act of Parliament. As this archaic interpretation was abandoned, philosophers went, in accordance with what politicians call the swing of the pendulum, to the other extreme. We can explain nothing, they said—in fact, we can know nothing—all we can do is to record facts. This modesty was impressive and it became popular. I know, at any rate, one scientific man who has acquired a great reputation for wisdom by repeating sufficiently often that he knows nothing, and, though his judgment may be true, this frame of mind is not inspiring. As a corrective to the older visionary claims, which centred round the meaning of the word "explain," the view that the first task of science is to record facts has no doubt had a good influence. Kirchhoff laid it down definitely that the object of science is to describe nature, but he did not thereby mean that it should be confined to recording detached observations; this would be the dullest and most unscientific procedure. Description, in the sense in which Kirchhoff uses it, consists in forming a comprehensive statement gathering together what, until then, was only a disconnected jumble of facts. Thus the apparently quite irregular motions of the planets, as observed from the earth, were first collected in tabular form. This was a necessary preliminary, but was not in itself a scientific investigation. Next came Kepler, who by means of three laws summed up the facts in their main outlines, and the description then took a more refined form, substituting half a page of printing for volumes of observations. Finally, Newton succeeded in predicting the planetary movements on the assumption of a gravitational attraction between all elements of matter. According to Kirchhoff, the chief merit of this discovery would lie in its condensing Kepler's three laws into one hypothesis. This point of view is not necessarily opposed to that of Poincaré, because it is exactly the simplicity of Newton's explanation that appeals most strongly to our æsthetic sense, but there is an important difference in the manner of expression. However beautiful an idea may be, it

[8] *English Review*, October, 1913.

loses its effect by being placed before us in an unattractive form. This criticism also applies to Mach, according to whom the object of science is to economise thought, just as it is the object of a machine to economise effort. Logically, this definition is justified, and it may be the best that can be given, if we prefer using a technical expression to confessing an emotional feeling. But why should we do so? Is it not better to recognise that human intelligence is affected by sentiment as much as by reasoning? It is a mistake for scientific men to dissociate themselves from the rest of humanity, by placing their motives on a different, and, at the best, only superficially higher, level. When an adventurous spirit, for instance, desires to organise an expedition to unknown regions of the world, we try to induce our Governments to provide the necessary funds by persuading them, and incidentally ourselves, that we do so because important scientific results may be expected from the expedition. This may actually be the case, but we are mainly affected by the same motives as the rest of the community; if the truth be told, we are as curious as others to know what every corner of the earth looks like, and we join them in wishing to encourage an enterprise requiring perseverance and involving danger.

I fully realise that the wish to justify one's own work in the eyes of the world will always lead to fresh attempts to find a formula expressing the objects which we desire to attain. Enough, however, has been said to show that the definition must take account of sentiment, without insisting too much upon it. Nor can we hope, in view of the variety of intellectual and emotional pleasures which combine to create the charm of science, to include all points of view, but if I were forced to make a choice I should say that the object of science is to predict the future. The wish to know what lies before us is one of the oldest and most enduring desires of human nature; often, no doubt, it has degenerated and given rise to perverted and ignoble longings, but its accomplishment, when it can be achieved by legitimate inquiry, is a source of the purest and most satisfying enjoyment that science can give. We feel that enjoyment each time we repeat an old and perhaps hackneyed experiment. The result is known beforehand, but be it only that we expect the colour of a chemical precipitate to be green or yellow, be it only that we expect a spot of light to move to the right or left, there is always a little tremor of excitement at the critical moment, and a satisfying feeling of pleasure when our expectation has been realised. That pleasure is, I think, enhanced when the experiment is not of our own making, but takes place uncontrolled by human power. In one of Heine's little verses he makes light of the tears of a young lady who is moved by the setting sun. "Be of good cheer," the poet consoles her, "this is only the ordinary succession of events; the sun sets in the evening and rises in the morning." If Heine had been a man of science, he would have known that the lady's tears found a higher justification in the thought of the immutable and inexorable regularity of the sun's rising and setting than in the fugitive colour impression of his descent below the horizon, and that her emotions ought to be intensified rather than allayed by the thought of his resurrection in the morning—everybody's life contains a few unforgettable moments which, at quite unexpected times, will vividly rise in his mind, and there are probably some in this hall who have experienced such moments at the beginning of a total eclipse of the sun. They have probably travelled far, and gone through months of preparation, for an event which only lasts a few minutes. The time of first contact is approaching, in a few seconds the moon is about to make its first incision in the solar disc, and now the observer's thoughts come crowding together. What if there were a mistake in our calculations? What if we had chosen a spot a few miles too far north or too far south? What if the laws of gravitation were ever so little at fault? But now at the predicted time, at the calculated spot on the sun's edge, the dark moon becomes visible, and the feeling of relief experienced concentrates into one tense instant all the gratitude we owe those who have given precision to the predictions of celestial movements, leaving them expressible by a simple law which can be written down in two lines. It is this simplicity of the law of gravitation, and its accuracy, which some day may show limitations, but has hitherto withstood all tests, that gives to astronomy its pre-eminence over all sciences.

Indeed, if we classify the different sections into which science may be divided, I think it may be said that their aim, in so far as it is not purely utilitarian, is always either historic or prophetic; and to the mathematician, history is only prophecy pursued in the negative direction. It is no argument against my definition of the objects of science, that a large section of its subdivisions has been, and to some extent still is, mainly occupied with the discovery and classification of facts; because such classification can only be a first step, preparing the way for a correlation into which the element of time must enter, and which therefore ultimately must depend either on history or prophecy.

Latterly men of science, and in particular physicists, have given increased attention to the intrinsic meaning of the concepts by means of which we express the facts of nature. Everything—who can deny it?—is ultimately reduced to sense impressions, and it has therefore been asserted that science is the study of the mind rather than of the outside world, the very existence of which may be denied. The physicist has thus invaded the realm of philosophy and metaphysics, and even claims that kingdom as his own. Two effects of these efforts, a paralysing pessimism and an obscure vagueness of expression, if not of thought, seriously threatened a few years ago to retard the healthy progress of the study of nature. If the outside world were only a dream, if we never could know what really lies behind it, the incentive which has moved those whose names stand out as landmarks in science is destroyed, and it is replaced by what? By a formula which only appeals to a few spirits entirely detached from the world in which they live. Metaphysicians and physicists will continue to look upon science from different points of view, and need not resent mutual criticisms of each other's methods or conclusions. For we must remember that most of the good that is done in this world is done by meddling with other people's affairs, and though the interference is always irritating and frequently futile, it proves after all that our interests converge towards a common centre.

According to Poincaré, the pleasure which the study of science confers consists in its power of uniting the beautiful and the useful; but it would be wrong to adopt this formula as a definition of the object of science, because it applies with equal force to all human studies. I go further, and say that the combination of the search for the beautiful with the achievement of the useful is the common interest of science and humanity. Some of us may tend more in one direction, some in another, but there must always remain a feeling of imperfection and only partial satisfaction unless we can unite the two fundamental desires of human nature.

I have warned you at the beginning of this discourse

not to beat the utilitarian drum too loudly, and I have laid stress throughout on the idealistic side, though the most compelling events of the moment seem to drive us in the other direction, and the near future will press the needs of material prosperity strongly upon us. I must guard myself, therefore, against one criticism which the trend of my remarks may invite. At times, when the struggle for existence keeps masses in permanent bondage, in a society in which a multitude of men and women have to face starvation, and when unfortunate, though purely accidental, surroundings in childhood drive the weak into misery, is it not futile to speak of æsthetic motives? Am I not, while endeavouring to find a common bond between all sections of the community, in reality drawing a ring round a small and privileged leisured class, telling them these enjoyments are for you and for you alone? Should I not have found a surer ground for the claims of science in its daily increasing necessity for the success of our manufactures and commerce?

I have said nothing to indicate that I do not put the highest value on this important function of science, which finds its noblest task in surrendering the richness of its achievements to the use of humanity. But I must ask you to reflect whether the achievement of wealth and power, to the exclusion of higher aims, can lead to more than a superficial prosperity which passes away, because it carries the virus of its own doom within it. Do we not find in the worship of material success the seed of the pernicious ambition which has maddened a nation, and plunged Europe into war? Is this contempt for all idealistic purposes not the origin of the mischievous doctrine that the power to possess confers the right to possess, and that possession is desirable in itself without regard to the use which is made of it? I must therefore insist that if we delight in enlisting the wealth accumulated in the earth, and all the power stored in the orbs of heaven, or in the orbits of atomic structure, it should not be because we place material wealth above intellectual enjoyment, but rather because we experience a double pleasure if the efforts of the mind contribute to the welfare of the nation. When Joule taught us to utilise the powers at our disposal to the best advantage he did it not—and his whole life is a proof of it—to increase either his own wealth or that of the nation, but because, brought up in commercial life and deeply imbued with the deep insight and genius of science, he found his greatest delight in that very combination of æsthetic satisfaction and useful achievement which Poincaré has so well described. And again, when another of our fellow-citizens, Henry Wilde, showed how electrical power can be accumulated until it became an efficient instrument for the economic transmission of work, he found his inspiration in the intellectual gratification it gave him, rather than in the expectation of material gain. I am drawing no ring round a privileged class, but urge that the hunger for intellectual enjoyment is universal, and everybody should be given the opportunity and leisure of appeasing it. The duty to work, the right to live, and the leisure to think are the three prime necessities of our existence, and when one of them fails we only live an incomplete life.

I should have no difficulty in illustrating by examples, drawn from personal experience, the power which the revelations of science can exert over a community steeped in the petty conflicts of ordinary life; but I must bring these remarks to a conclusion, and content myself with the account of one incident.

An American friend, who possessed a powerful telescope, one night received the visit of an ardent politician. It was the time of a Presidential election, Bryan and Taft being the opposing candidates, and feeling ran high. After looking at clusters of stars and other celestial objects, and having received answers to his various questions, the visitor turned to my friend:—

"And all these stars I see," he asked, "what space in the heaven do they occupy?"

"About the area of the moon."

"And you tell me that every one of them is a sun like our own?"

"Yes."

"And that each of them may have a number of planets circulating round them like our sun?"

"Yes."

"And that there may be life on each of these planets?"

"We cannot tell that, but it is quite possible that there may be life on many of them."

And after pondering for some time, the politician rose and said: "It does not matter after all whether Taft or Bryan gets in."

Happy were the times when it could be said with truth that the strife of politics counted as nothing before the silent display of the heavens. Mightier issues are at stake to-day: for in the struggle which convulses the world, all intellectual pursuits are vitally affected, and science gladly gives all the power she wields to the service of the State. Sorrowfully she covers her face because that power, acquired through the noblest efforts of the sons of all nations, was never meant for death and destruction; gladly she helps, because a war wantonly provoked threatens civilisation, and only through victory shall we achieve a peace in which once more science can hold up her head, proud of her strength to preserve the intellectual freedom which is worth more than material prosperity, to defeat the spirit of evil that destroys the sense of brotherhood among nations, and to spread the love of truth.

SECTION A.

MATHEMATICS AND PHYSICS.

OPENING ADDRESS (SLIGHTLY ABRIDGED) BY SIR F. W. DYSON, M.A., LL.D., F.R.S., PRESIDENT OF THE SECTION.

ALTHOUGH at the present time our minds are largely absorbed by the war, the meeting of the British Association in Manchester indicates that we consider it right to make our annual review of scientific progress. I shall therefore make no apology for choosing the same subject for my address as I should have chosen in other circumstances. It is a subject far removed from war, being an account of the manner in which astronomers have with telescopes and spectroscopes investigated the skies and the conclusions they have reached on what Herschel called "The Construction of the Heavens."

Our knowledge of the fixed stars, as they were called by the old astronomers, is of comparatively recent origin, and is derived from two sources: (1) the measurement of small changes in the positions of the stars in the sky, and (2) the analysis of the light received from them and the measurement of its amount. To this end the numerous instruments of a modern observatory have been devised. The desire to examine fainter objects, and still more the necessity of increasing the accuracy of observations, has brought about a continuous improvement in the range and accuracy of astronomical instruments. Methods which had been perfected for observations of a few stars have been extended so that they can be applied to a large number. For these reasons the progress

of sidereal astronomy may seem to have gone on slowly for a time. The more rapid progress of recent years arises from the accumulation of data, for which we are indebted to generations of astronomers, and from the gradual increase in power and perfection of our instruments.

The first insight into the stars as a whole naturally came from the survey of their numbers and distribution; and Herschel, who constructed the first great telescopes, explored the heavens with untiring skill and energy, and speculated boldly on his observations, is justly regarded as the founder of sidereal astronomy. In his great paper "On the Construction of the Heavens," Herschel gives the rules by which he was guided, which I should like to quote, as they may well serve as a motto to all who are engaged in the observational sciences:—

"But first let me mention that if we would hope to make any progress in an investigation of this delicate nature we ought to avoid two opposite extremes of which I can hardly say which is the most dangerous. If we indulge a fanciful imagination and build worlds of our own, we must not wonder at our going wide from the path of truth and nature; but these will vanish like the Cartesian vortices, that soon gave way when better theories were offered. On the other hand, if we add observation to observation, without attempting to draw not only certain conclusions but also conjectural views from them, we offend against the very end for which only observations ought to be made. I will endeavour to keep a proper medium; but if I should deviate from that I could wish not to fall into the latter error." In this spirit he discussed the "star gauges" or counts of stars visible with his great reflector in different parts of the sky, and concluded from them that the stars form a cluster which stretches to an unknown but finite distance, considerably greater in the plane of the Milky Way than in the perpendicular direction. He gave this distance as 497 times that of Sirius. He did not hesitate to advance the theory that some of the nebulæ were similar clusters of stars, of which that in Andromeda, judging from its size, was the nearest. Herschel had no means of telling the scale of the sidereal system, though he probably supposed the parallax of Sirius to be of the order of 1″.

Though some of the assumptions made by Herschel are open to criticism, the result at which he arrived is correct in its general outline. I shall attempt to give a brief account of some of the principal methods used to obtain more definite knowledge of the extent and constitution of this "island universe." The stars of which most is known are, in general, those nearest to us. If the distance of a star has been measured, its co-ordinates, velocity perpendicular to the line of sight, and luminosity are easily found. In the case of a double star the orbit of which is known the mass may also be determined. But only a very small proportion of the stars are sufficiently near for the distance to be determinable with any accuracy. Taking the distance corresponding to a parallax of 1″ or the parsec as unit—*i.e.* 200,000 times the distance of the earth from the sun—fairly accurate determinations can be made up to a distance of 25 parsecs, but only rough ones for greater distances.

For much greater distances average results are obtainable from proper motions, and the mean distances of particular classes of stars—for instance, stars of a given magnitude or given type of spectrum—can be found with confidence up to a distance of 500 parsecs, and with considerable uncertainty to twice this distance. The density of stars in space as a function of the distance, the percentage of stars within different limits of luminosity, the general trend of the movements of stars and their average velocities can also be found, within the same limits of distance.

For all distances, provided the star is sufficiently bright, its velocity to or from the earth can be measured. The general consideration of these velocities supplies complementary data which cannot be obtained from proper motions, and confirms other results obtained by their means. For distances greater than 1000 parsecs our knowledge is generally very vague. We have to rely on what can be learned from the amount and colour of the light of the stars, and from their numbers in different parts of the sky.

Parallax.

Let us begin with the portion of space nearest to us, within which the parallaxes of stars are determinable. The successful determination of stellar parallax by Bessel, Struve, and Henderson in 1838 was a landmark in sidereal astronomy. The distances of three separate stars were successfully measured, and for the first time the sounding line which astronomers had for centuries been throwing into space touched bottom. The employment of the heliometer which Bessel introduced was the main source of our knowledge of the distances of stars until the end of the nineteenth century, and resulted in fairly satisfactory determination of the parallaxes of nearly one hundred stars. For the part of space nearest to us this survey is sufficiently complete for us to infer the average distances of the stars from one another—2½ to 3 parsecs. The parallax determinations of double stars of known orbits lead to the result that the masses of stars have not a very great range, but lie between forty times and one-tenth of the mass of the sun.

When the absolute luminosities of the stars the distances of which have been measured are calculated, it is found that, unlike the masses, they exhibit a very great range. For example, Sirius radiates forty-eight times as much light as the sun, and Groombridge 34 only one-hundredth part. This does not represent anything like the complete range, and Canopus, for example, may be ten thousand times as luminous as the sun. But among the stars near the solar system, the absolute luminosity appears to vary with the type of spectrum. Thus Sirius, of type A, a blue hydrogen star, is forty-eight times as luminous as the sun; Procyon of type F5—bluer than the sun, but not so blue as Sirius—ten times; α Centauri, which is nearly of solar type, is twice as luminous. 61 Cygni of type K5—redder than the sun—one-tenth as luminous; while the still redder star of type Ma, Gr 34, is only one-hundredth as luminous. In the neighbourhood of the solar system one-third of the stars are more luminous and two-thirds less luminous than the sun. The luminosity decreases as the type of spectrum changes from A to M, *i.e.* from the blue stars to the red stars.

These three results as to the density in space, the mass, and the luminosity have been derived from a very small number of stars. They show the great value of accurate determinations of stellar parallax. So soon as the parallax is known, all the other observational data are immediately utilisable. At the commencement of the present century the parallaxes of perhaps eighty stars were known with tolerable accuracy. Happily the number is now rapidly increasing by the use of photographic methods. Within the last year or two, the parallaxes of nearly two hundred stars have been determined and published. This year a committeee of the American Astronomical Society, under the presidency of Prof. Schlesinger, has been formed to co-ordinate the work of six or seven American and one or two English observatories. The combined programme contains 1100 stars, of which

400 are being measured by more than one observatory. We may expect results at the rate of two hundred a year, and may therefore hope for a rapid increase of our knowledge of the stars within our immediate neighbourhood.

Velocities in the Line of Sight.

The determination of radial velocities was initiated by Huggins in the early 'sixties, but trustworthy results were not obtained until photographic methods were introduced by Vogel in 1890. Since that time further increase in accuracy has been made, and the velocity of a bright star with sharp lines is determinable (apart from a systematic error not wholly explained) with an accuracy of ¼ kilometre per second. As the average velocities of these stars are between 10 and 20 kilometres a second, the proportional accuracy is of a higher order than can be generally obtained in parallax determinations or in other data of sidereal astronomy. A number of observatories in the United States and Europe, as well as in South America, the Cape, and Canada, are engaged in this work. Especially at the Lick Observatory under Prof. Campbell's direction, the combination of a large telescope, a well-designed spectroscope, and excellent climatic conditions have been utilised to carry out a bold programme. At that observatory, with an offshoot at Cerro San Christobal in Chile, for the observations of stars in the southern hemisphere, the velocities of 1200 of the brightest stars in the sky have been determined. Among the results achieved is a determination of the direction and amount of the solar motion. The direction serves to confirm the results from proper motions, but the velocity is only obtainable accurately by this method. This quantity, which enters as a fundamental constant in nearly all researches dealing with proper motion, is given by Campbell at 19·5 kilometres per second, or 4·1 times the distance of the earth from the sun per annum, though there is some uncertainty arising from a systematic error of unknown origin.

The observations of radial velocities have shown within what limits the velocities of stars lie and have given a general idea of their distribution. The most important result, and one of a somewhat surprising character, is that the mean velocities of stars, the motion of the sun being abstracted, increase with the type of spectrum. Thus the stars of type B, the helium stars, the stars of the highest temperature, have average radial velocities of only 6·5 kilometres per second; the hydrogen stars of type A have average velocities of 11 kilometres per second; the solar stars of 15 kilometres per second; while for red stars of types K and M it has increased slightly more to 17 kilometres per second. Further, the few planetary nebulæ—*i.e.* condensed nebulæ with bright line spectra—have average velocities of 25 kilometres per second. There can be no question of the substantial accuracy of these results, as they are closely confirmed by discussions of proper motions. They are, however, very difficult to understand. On the face of it, there does not seem any reason why stars of a high temperature should have specially high velocities. A suggestion has been thrown out by Dr. Halm that as the helium stars have greater masses, these results are in accordance with an equi-partition of energy. But the distances of stars apart is so great that it seems impossible that this could be brought about by their interaction. Prof. Eddington suggests that the velocities may be an indication of the part of space at which the stars were formed (*e.g.* stars of small mass in outlying portions), and represents the kinetic energy they have acquired in arriving at their present positions.

The stars the radial velocities of which have been determined are, generally speaking, brighter than the fifth magnitude. Fainter stars are now being observed. At the Mount Wilson Observatory, Prof. Adams has determined the velocities of stars of known parallaxes, as there are great advantages in obtaining complete data for stars where possible. Extension of line-of-sight determinations to fainter stars is sure to bring a harvest of useful results, and a number of great telescopes are engaged, and others will shortly join in this important work.

Proper Motions.

As proper motions are determined by the comparison of the positions of stars at two different epochs, they get to be known with constantly increasing accuracy as the time interval increases. The stars visible to the naked eye in the northern hemisphere were accurately observed by Bradley in 1755. Many thousands of observations of faint stars down to about 9·0m. were made in the first half of the nineteenth century. An extensive scheme of re-observation was carried out about 1875 under the auspices of the Astronomische Gesellschaft. A great deal of re-observation of stars brighter than the ninth magnitude has been made this century in connection with the photographic survey of the heavens. For the bright stars all available material has been utilised and their proper motions have been well determined, and for the fainter stars this is being gradually accomplished.

Proper motions differ widely and irregularly in amount and direction. Herschel observed a tendency of a few stars to move towards one point of the sky, and attributed this sign of regularity to a movement of the solar system in the opposite direction. But puzzling differences given by different methods remained unexplained until the difficulty was resolved by Prof. Kapteyn in a paper read before this section of the British Association at its meeting in South Africa ten years ago. He showed that the proper motions had a general tendency towards two different points of the sky and not towards one only, as would be expected if the motions of the stars themselves were haphazard, but viewed from a point in rapid motion. He concluded from this that there was a general tendency of the stars to stream in two opposite directions. It is interesting to notice that this great discovery was made by a simple graphical examination of the proper motions of stars in different regions of the sky, after the author had spent much time in examining and criticising the different methods which had been adopted for the determination of the direction of the solar motion. The subject was brought into a clearer and more exact shape by the analytical formulation given to it by Prof. Eddington, and after him by Prof. Schwarzschild.

This star-streaming is corroborated by observations of velocities in the line of sight. It applies—with the exception of the helium stars—to all stars which are near enough for their proper motions to be determinable. We may say with certainty that it extends to stars at distances of two or three hundred parsecs; it may extend much further, but I do not think we have at present much evidence of this. Prof. Turner pointed out that the convergence of proper motions did not necessarily imply movements in parallel directions, and suggested that the star-streams were movements of stars to and from a centre. The agreement of the radial velocities with the proper motions seems to me to be opposed to this suggestion, and to show that star-streaming indicates approximate parallelism in two opposite directions in the motions of the stars examined. As the great majority of these stars are comparatively near to us, it is possible that this

parallelism is mainly confined to them, and indicates the general directions of the orbital motions of stars in the neighbourhood. An attempted explanation on these lines, as on Prof. Turner's, implies that the sun is some distance from the centre of the stellar system.

A discovery of an entirely different character was made by Prof. Boss in 1908. He spent many years in constructing a great catalogue giving the most accurate positions and motions of 6200 stars obtainable from all existing observations. This catalogue, which was published by the Carnegie Institute, was intended as a preliminary to a still larger one which would give the accurate positions and motions of all the stars down to the seventh magnitude. In the course of this work Prof. Boss found that forty or fifty stars scattered over a considerable region of the sky near the constellation Taurus were all moving towards the same point in the sky and with nearly the same angular velocity. He inferred that these stars were all moving in parallel directions with an equal linear velocity, and the supposition was verified, in the case of several of them, by the determination of their radial velocities. From these data he was able to derive the distance of each star and thus its position in space. The existence of a large group of stars, separated from one another by great distances, and all having the same motion in space, is a very remarkable phenomenon. It shows, as was pointed out by Prof. Eddington, how small is the gravitational action of one star on another, and that the movement of each star is determined by the total attraction of the whole mass of the stars. Several other interesting moving clusters have been found since. For all the stars belonging to these clusters, the distances have been found, and from them luminosities and velocities of individual stars, particulars which are generally only obtainable for stars much nearer to us.

Proper motions are the main source of our knowledge of the distances of stars which are beyond the reach of determination by annual parallax. If a star were known to be at rest its distance could be calculated from the shift of its apparent position caused by the translation of the solar motion. As the solar system moves 410 times the distance of the earth from the sun in a century, this gives a displacement of 1″ for a star at the distance of 500 parsecs. This method has been applied by Kapteyn to determine the distances of the helium stars, as their velocities are sufficiently small to be neglected in comparison with that of the solar system. But generally it is only possible to find the mean distances of groups of stars of such size that it may be assumed that the peculiar motions neutralise one another in the mean. For example, the average distance of stars of type A, or stars of the fifth magnitude, or any other group desired may be found. In this way Kapteyn has found from the Bradley stars that the mean parallax of stars of magnitude m is given by the formula

$$\log. \pi_m = -1{\cdot}108 - 0{\cdot}125\, m.$$

In conjunction with another observational law which expresses the number of stars as a function of the magnitude, this leads to a determination of the density of stars in space at different distances from us, and also of the "luminosity law," *i.e.* the percentage of stars of different absolute brightness. Profs. Seeliger and Kapteyn have shown in this way that there is a considerable falling off of star-density as we go further from the solar system. It seems to me very necessary that this should be investigated in greater detail for different parts of the sky separately. A general mathematical solution of general questions which arise in the treatment of astronomical statistics has been given by Prof. Schwarzschild. His investigations are of the greatest value in showing the exact dependence of the density, luminosity, and velocity laws on the statistical facts which can be collected from observation. The many interesting statistical studies which have been made are liable to be rather bewildering without the guidance furnished by a general mathematical survey of the whole position.

When the proper motions are considered in relation to the spectral types of the stars, the small average velocities of the hydrogen stars and still smaller ones of the helium stars found from line-of-sight observations are confirmed. If stars up to a definite limit of apparent magnitude, say, to 6·0m., or between certain limits, say 8·0m. and 9·0m., are considered, then the solar stars are found to be much nearer than either the red or the blue stars. Thus both red and blue stars must be of greater intrinsic luminosity than the solar stars. As regards blue stars, this agrees with results given by parallax observations. But the red stars appear to consist of two classes, one of great and one of feeble luminosity, and it does not seem that a sufficient explanation is given by the fact that a selection of stars brighter than any given apparent magnitude will include the very luminous stars which are at a great distance, but only such stars of feeble luminosity as are very near.

The significance of these facts was pointed out by Prof. Hertzsprung and Prof. Russell. They have a very important bearing on the question of stellar evolution, a subject for discussion at a later meeting this week. From the geometrical point of view of my address these facts are of importance in that they help to classify the extraordinarily large range found in the luminosities of stars. Putting the matter somewhat broadly, the A stars, or hydrogen stars, are on the average intrinsically 5 magnitudes brighter than the sun, whilst the range in their magnitudes is such that half of them are within ¾ magnitude of the mean value. The stars of type M, very red stars, are of two classes. Some of them are as luminous as the A stars, and have a similar range about a mean value 5 magnitudes brighter than the sun. Others, on the contrary, have a mean intrinsic brightness 5 magnitudes fainter than the sun and with the same probable deviation of ¾ magnitude. Between the types M and A there are two classes the distance apart of which diminishes as the stars become bluer. The facts in support of this contention are very forcibly presented by Prof. Russell in NATURE in May, 1914. If this hypothesis is true, and it seems to me there is much to be said in its favour, then the apparent magnitude combined with the type of spectrum will give a very fair approximation to the distances of stars which are too far away for their proper motions to be determinable with accuracy.

In dealing with the proper motions of the brighter stars, the sky has been considered as a whole. Now that the direction and amount of the solar motion are known, we may hope that, as more proper motions become available, the different parts of the sky will be studied separately. In this way we shall obtain more detailed knowledge of the streaming, and also of the mean distances of stars of different magnitudes in all parts of the sky, leading to a determination of how the density of stars in space changes in different directions. A second line of research which may be expected to give important results is in the relationship of proper motions to spectral type. There is in preparation at Harvard College by Miss Cannon, under Prof. Pickering's direction, a catalogue giving the type of spectrum of every star brighter than the ninth magnitude. It would be very desirable to determine the proper motions of all these stars. If all the material available is examined it should be possible to do this to a very large extent.

Photometry and Colour.

For the more distant parts of the heavens proper motions are an uncertain guide, and we must depend on what can be learned from the light of the stars by means of stellar photometry, determinations of colour, and studies of stellar spectra. Speaking generally, we attempt to discover from the nearer stars sufficient about their intrinsic luminosities to enable us to use the apparent magnitude as an index of the distances of the stars which are further away. The most striking example is found in Prof. Hertzsprung's determination of the distance of the small Magellanic cloud. From a knowledge of the characteristics of the Cepheid variables found in this cloud by Miss Leavitt, and their apparent magnitude, he deduced the distance of the cloud as 10,000 parsecs.

Much attention has been given of late years to stellar photometry. In 1899 Prof. Pickering published the Revised Harvard Photometry giving the magnitudes of all stars brighter than 6·5m. In 1907 Messrs. Müller and Kempf completed a determination of 14,199 stars of the northern hemisphere brighter than 7·5m. In 1908 a catalogue of 36,682 stars fainter than 6·5m. was published at Harvard. These determinations derive additional importance as they give the means of standardising estimates of magnitude made by eye, particularly the many thousands of the Bonn Durchmusterung.

By the labours of Prof. Pickering and his colleagues at Harvard, Prof. Schwarzschild, Prof. Parkhurst at Yerkes, Prof. Seares at Mount Wilson, and others, the determinations of the magnitudes of stars by photography has made rapid strides. As yet no complete catalogues of photographic magnitude corresponding to the Revised Harvard Photometry have been published, though considerable parts of the sky and special areas, such as the Pleiades, have been carefully studied. The determination of the photographic magnitudes of any stars which may be required is, however, a comparatively simple matter when the magnitudes of sufficient standard stars have been found. A trustworthy and uniform scale has been to a large extent secured by the use of extra-focal images, gratings, and screens in front of the object glass, and the study of the effects of different apertures and different times of exposure.

At Harvard and Mount Wilson, standard magnitudes of stars near the north pole have been published extending to nearly the twentieth magnitude. In the part of the range extending from 10·om. to 16·om. these agree very satisfactorily. There is, however, a difference of 0·4m. in the scale between 6·om. and 10·om. which needs to be cleared up.

A uniform and accurate scale of magnitude is of fundamental importance in counts of the numbers of stars. Such counts aim at the determination of two things: (1) how the numbers vary in different parts of the sky, and (2) what is the ratio of the number of stars of each magnitude to that of the preceding magnitude in the same area of the sky. The counts of stars from the gauges of Sir William and Sir John Herschel, those of the stars contained in the Bonn Durchmusterung, those made by Prof. Celoria, and the recent counts of the Franklin-Adams plates by Dr. Chapman and Mr. Melotte, all agree in showing a continuous increase of stars as we proceed from the pole of the galaxy to the galaxy itself. The importance of this fact is that it shows a close connection between the Milky Way and the stars nearer to us. The Milky Way is not a system of stars beyond the others, but is the primary feature of our "island universe."

Photometric observations have acquired additional importance from the differences between photographic and visual magnitudes. The ordinary plate is more sensitive to blue light than the eye, and the difference between the photographic and visual (or photo-visual) magnitude of a star is an index of the colour. The colour index is found by observation to be related very closely to the type of spectrum. Prof. Seares has shown from the colour indices that as the stars become fainter they become progressively redder. Prof. Hertzsprung has found the same thing by the use of a grating in front of the object glass. Among stars of 17·om. visual magnitude, Seares found none with a colour index less than 0·7; this is approximately the colour index of a star of solar type, *i.e.* near the middle of the range from blue stars to red stars.

There are three ways in which this may occur. The stars may be bright but very distant red stars; or they may be faint red stars, like those in the immediate neighbourhood of the sun; or there may have been an absorption of blue light. It is not possible to say in what proportion these causes have contributed. The red stars of 9·om. and 10·om. are nearly all very luminous but distant bodies, but it seems likely that stars of 17·om. will contain a greater proportion of stars of small luminosity.

The absorption of light in space is very small, and as yet imperfectly determined. Prof. Kapteyn and Mr. Jones, by comparing the colour indices of stars of large and small proper motion, make the difference between the absorption of photographic and visual light as 1m. in 2000 parsecs. The question has been examined directly by Prof. Adams, who has obtained spectra of near and distant stars which are identical as regards their lines, and has examined the distribution of the continuous light. This direct method of comparison showed that the more distant star was always weaker in violet light. But as both these investigations show that very luminous stars are intrinsically somewhat bluer than less luminous stars of the same spectral type, the two causes require further research for their disentanglement. The question is of importance, as it may serve in some cases to determine the distances of very remote bodies the type of spectrum of which is known.

It must be admitted that we are as yet very ignorant of the more distant parts of the "island universe." For example, we can make little more than guesses at the distance of the Milky Way, or say what part is nearest to us, what are its movements, and so on. But, nevertheless, the whole subject of the construction of the heavens has been opened up in a remarkable manner in the last few years. The methods now employed seem competent to produce a tolerably good model showing the co-ordinates and velocities of the stars as well as their effective temperatures and the amount of light they radiate. Industry in the collection of accurate data is required, along with constant attempts to interpret them as they are collected. The more accurate and detailed our knowledge of the stellar system as it is now, the better will be our position for the dynamical and physical study of its history and evolution.

NOTES.

THE director of the Meteorological Office reports that information has been received from the Seismological Observatory at Eskdalemuir, Scotland, of the record of a large earthquake which occurred at 1 a.m. on Tuesday, September 7. The computed position of the epicentre is lat. 9° N., long. 86° W., with a possible error of 10°. The position mentioned is in the Pacific Ocean, about 70 miles from Cape Blanco

in Costa Rica, and a circle of 10° radius drawn from this point as centre includes a portion of Central America and the Isthmus of Panama.

A REUTER message from Paris states that the Ministry of Foreign Affairs has sent to the Academy of Sciences a note reporting the discovery of mineral springs in Colorado containing radium in such large quantities that they may lead to the industrial extraction in America of radium, and the reduction of price to less than one-quarter the present rate per gram.

THE Ministry of Munitions announces that the Munitions Inventions Branch, which was recently constituted by the Minister of Munitions to deal with projects for inventions relating to munitions for warfare on land, or matters appertaining thereto, has now been removed from Armament Buildings, Whitehall, to accessible and commodious quarters in Princes Street, Storey's Gate, S.W. (hitherto the premises of the Whitehall Club), to which all future communications should be addressed. The department is now in working order, and is already dealing with a large number of proposals. The comptroller, Mr. E. W. Moir, is being assisted in this work by an advisory panel of scientific experts, whose names were announced in NATURE of August 19 (p. 678). This body is now at work in committees, and every proposal receives consideration from them.

IN commemoration of Capt. Cook, a tablet has been placed on the school at Great Ayton, Cleveland, where the navigator received his education; a scholarship has also been established at Marton, in the same neighbourhood, which was Capt. Cook's birthplace. The cost of both has been provided out of the surplus of the fund raised for the erection of the Cook memorial in London.

WE are informed that Mr. A. Gibb Maitland, Government Geologist and Director of the Geological Survey, Western Australia, has been appointed President of the Royal Society of Western Australia for the session 1915–16.

WE learn from the Allahabad *Pioneer Mail* that Dr. N. Annandale, superintendent of the Indian Museum, Calcutta, is to spend the greater part of his six months' leave of absence in Siam and Japan, studying the fauna of the lake regions, and that he will prepare and submit a report on the geological and entomological collections in the two countries referred to.

WE are glad to learn from Cambridge that the announcement in the *Times* of September 2 that Capt. James Romanes had been killed at the Dardanelles on August 31 is incorrect. A telegram from Gibraltar states that Capt. Romanes is returning home slightly wounded.

WE notice with much regret the announcement of the death, on September 4, at forty-four years of age, of Prof. D. T. Gwynne-Vaughan, professor of botany at University College, Reading.

THE death is announced of Julius von Payer, who, in a memorable Austro-Hungarian Arctic Expedition in 1872–74, under the leadership of Lieut. Weyprecht and himself, discovered and explored the coast of Franz-Josef Land.

THE death is announced of Mr. F. Higgins, chief engineer to the Exchange Telegraph Company. He began his career in the Post Office Telegraph Department, was Superintendent of Telegraphs in Mauritius for a time, and entered the service of the Exchange Telegraph Company in 1873, when he began to direct his attention to the development of type-printing telegraphs in the various forms now familiarly known as "tape" instruments. In this he was successful, as, besides perfecting several forms of "relays," he largely increased the speed of the instruments. In addition, he invented an instrument known as the column printer for printing on a broad band of paper. He was also the patentee of numerous inventions in electric fire alarms.

BY the death of Mr. Thomas Carrington-Smith agriculture has lost a prominent and characteristic personality, and one who did much to make British farming what it now is. He entered his farm about the middle of the 'fifties, and maintained an uninterrupted tenancy of some sixty years; thus he farmed through the prosperous times of the 'sixties, the disasters of '79, the depression of the 'nineties, and he lived to see high prices setting in once more. His long experience was placed ungrudgingly at the service of his fellow-agriculturists, and he played a considerable part in bringing about the legislation that was necessary before farmers could alter their systems of working. No industry is subject to more restrictions than agriculture, probably because farmers rarely work on more than an annual lease. Legislation is therefore necessary from time to time to effect adjustments of the various interests involved. In all this Mr. Carrington-Smith played a prominent part, and his name is associated with legislation affecting tenant right reform, swine fever, cattle disease, agricultural rates, and the sale of margarine. He was active, both on the advisory side, as chairman of the Dairy Products Committee of the Central Chamber of Agriculture, and on the administrative side, as a member of the Staffordshire County Council. He also wrote a number of papers on agricultural subjects.

WE announced, with regret, in our last number, the death of Mr. Henry Crookes, which took place after a short illness at his residence, 109 Ladbroke Road, W., on August 28. Henry Crookes was the eldest son of Sir William and Lady Crookes, and for many years he had been closely associated with his father in several branches of scientific activity. He was an associate of the Royal School of Mines, and was elected a fellow of the Chemical Society in 1902. Quiet and unassuming in disposition, his work was not largely known outside his immediate circle of friends and collaborators. Some years ago he spent a considerable time in South Africa, engaged in work connected with gold mining and the extraction of gold from residues by the cyanide process. At this time he unfortunately contracted intermittent fever, which necessitated his return to England, and the effects of which never left him. It is to this circumstance that his death at a comparatively early age is largely

due. He contributed many papers to the scientific Press. Among them are the following:—"Action of Permanganate of Potash and Acetic Acid on Bacteria in Thames Water," "Bactericidal Properties of the Emanations from Radium," "Volcanic Dust," "Photographs and Living Cultures of Bacillus Phosphorescens," "Metallic Colloids and their Bactericidal Properties." Of late years his time was occupied chiefly in the analysis of the water supply of London and several large towns in the provinces, particularly with regard to their bacterial contamination. He was the discoverer of a process for the preparation of stable colloidal solutions of silver and other metals, the valuable properties of which are now recognised by the medical profession, and he was actively engaged upon these researches and preparations up to the time of his recent fatal illness. He will be greatly missed in his particular sphere of activity. In 1883 he married the daughter of the late C. E. Spagnoletti. Our sincere sympathy is offered to his widow, as well as to Sir William and Lady Crookes for their great loss at a time when they are naturally ill able to bear the strain.

CAPT. T. P. BLACK, whose death in the Dardanelles was announced in NATURE last week, was the eldest son of the late Mr. Geo. B. Black. Born at Shotts, Lanarkshire, in 1878, he was educated at Aberdeen and Darlington, gained a scholarship to Durham University, and graduated B.A., with honours, in 1898. At this time he visited the Dardanelles, Constantinople, Skutari, and the Crimea. On his return he graduated M.A. and B.Sc., with honours, at Durham, and researched on radio-activity. He next held a science research scholarship at Strassburg, taking the Ph.D. for original work in physics carried out under Profs. Braun and Zenneck. An abstract from his doctoral dissertation, published in the *Annalen der Physik* for January, 1906, bore the title, "On the Resistance of Coils for Quick Electric Oscillations." After being an assistant at Newcastle, he became in 1906 lecturer and demonstrator in physics at University College, Nottingham. While here he was joint author of an "Introduction to Practical Physics." He was justly valued as an able teacher, and was deservedly popular with staff and students. In 1911 he accepted the registrarship of the college and so passed to new successes in a wider sphere of usefulness. Thus his soldier's death was but the crowning glory of a strenuous life, rich in distinction and promise.

THE first number of the Journal of the British Science Guild, which has just been issued, contains a verbatim report of the ninth annual meeting of the guild, held on July 1, and the address on "The National Organisation of Science," delivered on that occasion by Sir William Ramsay. It is hoped that the publication of the Journal will serve not only to keep members in touch with the results of the guild's activities in many directions, but also will be the means of securing increased support for its work. The main purpose of the guild is the promotion of scientific method and organisation in all national affairs; and there are sufficient sympathisers with this aim to increase the membership a thousandfold. The minimum annual subscription is only half a crown; life membership is obtained for two guineas, and the subscription for a life fellow is ten guineas. Any British subject is eligible to join the guild, and all who believe in the services which science can render to the arts of peace as well as those of war should give a practical sign of their conviction by becoming members or fellows. The offices of the guild are at 199 Piccadilly, London, W., and the secretary will be glad to send particulars of committees and of publications upon application.

IN the *Times* of September 4 Mr. R. C. Shaw announces the discovery at Caervoran, on the Roman Wall three miles east of Gilsland, in Northumberland, of a remarkable bronze measure of the Roman period. Such officially certified measures are very rare. On the present specimen the name of the Emperor Domitian, in whose consulate in A.D. 90 the measure was tested, has been obliterated, owing to the hatred felt towards him after his death. The measure contains 17½ sectarii, about 30 lb. of wine, or rather more than two gallons, and 8 lb. have been allowed as the weight of the material. Prof. Haverfield is uncertain whether it was really certified under the order of the Emperor, or whether it is a private venture, masquerading as official. In any case, there is no question of the date, and the discovery is of considerable antiquarian interest.

IN *Man* for September Mr. R. Grant Brown discusses the modesty of Burman women. He points out a fact familiar to all visitors to a religious fair in northern India, that women when bathing manage their scanty drapery with such dexterity that any suggestion of immodesty is avoided. The principle underlying this observance of propriety is that every Burman lady believes herself to be under the watch of twelve spirits, six of whom are good and six evil, and it is supposed that any exposure of the human form in their presence is a source of danger. Even in the wearing of the scanty tamein, or waist-cloth, she contrives to observe the laws of propriety. The only case in which decency is violated is when a woman really loses her head in the course of a quarrel with a neighbour, and both combatants roll in the gutter without any regard for decency. The explanation is that they believe that in thus humiliating an opponent they have vindicated the justice of their cause and brought the enemy into contempt.

A PAPER entitled "The History and Functions of Botanic Gardens," by Mr. A. W. Hill, assistant director of the Royal Gardens, Kew, was read by invitation at the twenty-fifth anniversary celebration of the Missouri Botanic Garden, October 15, 1914, and has been reprinted from the Annals of the Missouri Garden (Vol. ii., pp. 185–240). This paper is mainly devoted to an extremely interesting and valuable historical summary of the founding of the various botanic gardens of the world from about the year 1000 B.C. onwards, and is illustrated by nine plates, three of which are remarkably fine collotype reproductions of photographs taken in Kew Gardens.

Two important papers appear in the *American Naturalist* for August. The first of these should be carefully read by all who are interested in problems of heredity. Herein Mr. E. M. East discusses at some length "The Chromosome View of Heredity and its Meaning to Plant-Breeders." He contends that the maximum possible difficulty in the improvement of animals, and plants, by hybridisation, usually depends directly upon the chromosome number. This being so, then there can be no question as to the importance of determining the number of chromosomes in a species before beginning a complex plant-breeding problem, and thus being able to comprehend the maximum possible difficulties that may be encountered. In the second paper Prof. A. C. Eycleshymer discusses the origin of bilaterality in vertebrates. From a study of the early embryonic stages he is of opinion that neither the position nor the direction of cleavage grooves has the slightest significance as far as the setting apart of definite embryonic areas is concerned. And further, that neither the position nor the direction of the cleavage grooves enables one to predict the long axis of the embryo, so that other phenomena, which may be of service, must be looked for. These he finds in the increased cellular activity of the active pole, which can be located with the advent of the first cleavage groove. This marks the head end of the embryo. The tail end is similarly marked by the early accelerated activity of the side of the egg, indicating the forthcoming blastopore, which definitely fixes the posterior end of the embryo. It necessarily follows that the median plane of the embryo must coincide with a line passing through the centres of the two.

THERE is much that may be profitably ruminated on in the *Museums Journal* for August, even by those who have no part in the conduct of museums. More especially we refer to the views expressed at the conference of the Museums Association held in London during July, as to the relation which should exist between museums and the various grades of educational institutions. In Manchester, where so many of the school buildings have been converted into military hospitals, a number of teachers have been sent to the museums to receive a thorough course of instruction on the various aspects of the museums to which they are sent, in order that, when peace returns to us, they may the more efficiently utilise the museums as sources of education. Many valuable suggestions for the further widening of the spheres of usefulness of museums were also made, some of which, at any rate, might well receive immediate attention. The address of the president, Mr. E. Rimbault Dibdin, might be read with much profit by the peace cranks who just now are so busy.

MR. G. B. WALSH makes some interesting observations on the causes determining the survival and extermination of insects in the manufacturing districts of Yorkshire in the *Entomologist's Monthly Magazine* for August. Drainage, cultivation, and moorland fires have done much, but blast-furnaces and chemical works have done more, to bring about the extinction of many insects that were once common in the areas surveyed. Some have contrived to thrive under the most adverse conditions. Thus he relates how two very local beetles, moorland species—*Miscodera arctica* and *Pterostichous vitreus*—are to be found, in some numbers, in a marsh traversed by a fœtid stream, and stinking most abominably of hydrogen sulphide. A slag heap bounds the marsh on either side, which receives the overflow from a neighbouring chemical works, while dust from calcining and blast-furnaces fills the air, which is saturated with the odour of rotten eggs. How insects the natural home of which is the breezy moorland can contrive to thrive under such appalling conditions is indeed a mystery. Specimens taken from this new habitat should be carefully compared with others obtained from the moorland to discover, if possible, whether any adaptations to the new environment have taken place.

THE accurate zoning of Carboniferous strata in the British Isles has received general attention since the pioneer work of A. Vaughan on the Avon section. L. B. Smyth, lecturer on palæontology in the University of Dublin, has now (Sci. Proc. R. Dublin Society, vol. xiv., 1915, p. 535) cleared up some obscure points in the sequence in the north of the county of Dublin, where a river from the Devonian land-surface entered the Carboniferous sea. A correlation is made between these Irish deposits and those of the English Lake District, described by E. J. Garwood. Several new species of corals, and a new genus, Arachniophyllum, are described. The old Arachnophyllum, by the by, has been absorbed in Strombodes; but it might have been well to direct attention to this, the new generic name being almost identical.

FROM a new consideration of the "Interglacial Gorges of Six Mile Creek at Ithaca, New York" (Journ. of Geology, vol. xxiii., 1915, p. 59), J. L. Rich and E. A. Filmer conclude that at least three glacial epochs are indicated, "separated by periods of time longer than that since the last epoch." The great Wisconsin ice-extension entered the interglacial stream-gorges, and deposited its drift there, without appreciably modifying their walls.

F. CHAPMAN describes a new genus of dibranchiate cephalopods, Notosepia, from the Oligocene of Victoria, Australia (Proc. R. Soc. Victoria, vol. xxvii., 1915, p. 357). Young forms have a recurved mucro at the termination of the pro-ostracum, recalling the Eocene Belosepia, while this becomes, in adult specimens, straightened towards the type known in the modern Sepia.

STUDENTS of meteorites will be glad to note the record of the rare calcium sulphide, Oldhamite, which crystallises in the cubic system, in the "carbonaceous chondrite" of Indarch, Russia (G. P. Merrill, Proc. U.S. Nat. Museum, vol. xlix., 1915, p. 109). Mr. Merrill quotes its occurrence in five other meteorites of varied composition, and points out that it may prove to be more widely diffused, since it is usually inconspicuous.

THE use of antiseptics or disinfectants for the treatment of wounds is limited by several factors. Thus many potent germicides may be irritating to the tissues

and poisonous to the system, *e.g.* mercuric chloride. The efficiency of a disinfectant is probably always reduced more or less by the albuminous constituents of the discharge from the wound. In a paper entitled "On the Use of Certain Antiseptic Substances in the Treatment of Infected Wounds" (*Brit. Med. Journal*, August 28, 1915, p. 318), by Dr. H. D. Dakin, of the Herter Laboratory, New York, some of the limitations of the commonly-used substances are detailed, and means for obviating them are discussed. Thus hypochlorite of soda is very active, but always contains free alkali, which is irritating. If, however, it be mixed with a weak polybasic acid, the latter will neutralise the free alkali without decomposing the hypochlorite. A solution of suitable concentration for direct application to wounds, containing 0·5–0·6 per cent. of sodium hypochlorite, may be prepared as follows:—140 grams of dry sodium carbonate (Na_2CO_3), or 400 grams of the crystalline salt (washing soda) is dissolved in 10 litres of tap-water, and 200 grams of chloride of lime (bleaching powder) are added. The mixture is well shaken, allowed to stand for half an hour; the clear liquid is then syphoned off from the precipitate of calcium carbonate and filtered through cotton-wool. To the clear filtrate 40 grams of boric acid are added, and when dissolved the resulting solution is ready for use, but it should not be kept longer than one week. It may be used for continued irrigation of wounds up to 1, or even 2, litres a day without harm. Other chlorinated organic compounds (certain chloroamides) are also being tested.

DISCUSSIONS of the anemographic observations recorded at Jubbulpore from May, 1889, to April, 1900, and at Belgaum from May, 1881, to April, 1904, are given as Nos. 5 and 6 of the Memoirs of the Indian Meteorological Department, vol. xix. The discussions have been carried out by W. A. Harwood, and an introduction is given by Dr. G. T. Walker, Director-General of Observatories in India. Some notes were left by Sir John Eliot on the Belgaum observations. Faulty exposure and inefficient working are alluded to as occasioning some discrepancies. Jubbulpore is at an elevation of 1327 ft. above sea-level, and a detailed description is given of the station. The climate is divided into three seasons: the dry, cool season, from October to February; the dry, hot season, from March to May; and the rainy season, from June to September. The variation of wind direction and velocity is given for each of these seasons and for the year, also for the several hours in each month, and details are shown both in a tabular form and graphically. Storm winds are also dealt with. Belgaum is 2539 ft. above sea-level, and the observations are similarly treated to those at Jubbulpore, the discussion being made separately for the cool season commencing in October and ending in February; the hot season in March, April, and May; and the south-west monsoon season in June and September.

IN the Journal of the Royal Statistical Society for July Mr. S. Rosenbaum analyses the effects of the war on the overseas trade of the United Kingdom. In order to estimate the probable value of the trade in each of the five months, August-December, 1914, if no war had taken place, the trade in January-July is multiplied by the average ratio, for each of the months, in the years 1904–13. A basis is thus obtained for separating, approximately at least, the effects of the war from the normal course of trade. So estimated, the collapse of the export trade due to the war was about 97,000,000*l.* in the first five months—a decline that was widely spread over nearly all classes of exports. If exports are valued on the basis of peace prices this decline is slightly lessened. Of the total export trade lost about 22,000,000*l.* would have taken place with enemy countries. As regards imports, the shrinkage was approximately 67 millions, or about one-fifth of the expected imports, but the ratio was a steadily declining one. It must be remembered, however, in this case that a considerable rise in prices partly masked the decline; in volume the decline must have been about one-fourth. Details are given in the paper for the several classes of exports and imports, and in the latter part some analysis is presented of the figures for January–April, 1915. During these months the state of affairs was largely altered. While exports were still heavily down, in February, March, and April the value of imports was greater than in the corresponding months of 1914, and this was a real increase, not in values only, but also in volume.

IN the same issue of the Journal there is a paper by Mr. Bernard Mallet and Mr. Strutt, in continuation of a paper published by Mr. Mallet in 1908, on the multiplier necessary for converting the value of estates passing at death, and declared for estate duty, into the value of capital wealth in the hands of the living. The value of the multiplier, 24, reached in the earlier paper was thought on several grounds to be too low, and the problem has now been re-attacked. The chief source of error was the assumption of too high a rate of mortality. Taking figures more nearly corresponding to the estate-leaving class the multiplier is raised to 28. Rather unexpectedly an often-suggested source of possible error—gifts *inter vivos*—it is argued, does not, in fact, affect the results, though this conclusion was disputed in the discussion that followed. A further amendment of the mortality rates used, made in reply to criticisms offered, suggests that the multiplier might be further raised to 30. Even this multiplier gives a value of total capital in the hands of the living of only 10,776,000,000*l.*, a value some two or three thousand millions less than that of several other estimates.

IN his concluding article on modern bullets in war and sport in *Engineering* for August 27, Fleet-Surgeon C. Marsh Beadnell says that hard-nosed bullet wounds of the lung are not as a rule fatal. When a hollow organ such as the stomach is perforated by a bullet, it sustains more damage if it contains fluid than if empty. The author fired a 0·303 bullet at a sheep's stomach, in the one case when it was full of water, and in the other case when empty, with the following results. The aperture in each wall of the empty organ was 0·2 in.; the aperture in the first wall of the full stomach was also 0·2 in.,

but that in the second wall was 0·7 in. From this it follows that a man hit after a full meal would have less chance of recovery than had this occurred when the organ was empty. Bullet wounds of the lung, provided no large vessels are touched, are seldom fatal in man or beast. The author has seen as many as a dozen men in one ward of a base hospital all convalescent from lung injuries.

In an article in *Engineering* for September 3, Mr. William Hovgaard discusses the *Lusitania* disaster, and draws therefrom the following conclusions:—(1) The principle of transverse subdivision should be considered as fundamental in the design of all vessels, merchant ships as well as warships, simply because the longitudinal stability is always much greater than the transverse, and in sea-going ships is generally about one hundred times as great. (2) Longitudinal subdivision is intrinsically pernicious, on account of the small transverse stability of all ordinary vessels, and should be used only where absolutely necessary. (3) All wing compartments, where such must be fitted, should either be so small that their heeling effect when flooded will be negligible, or, if that is impracticable, as may be the case in warships and auxiliary cruisers, they should be in permanent connection with corresponding compartments on the other side of the ship, so as to eliminate the heeling effect automatically. Provision may be made, in addition, for pumping water into the side compartments. In pure merchant vessels, no side bunkers or other longitudinal compartments of so large a volume as to require such means of compensation should be allowed.

The *Engineer* for September 3 has an article on the employment of women as machinists, with special reference to the various shell factories organised by Sir William Beardmore. About 800 girls are now employed in these factories, and the number will shortly be very largely increased. Some of these girls have now been at work for about four months, and were first trained by special instructors selected from men employed in other departments of Messrs. Beardmore's works, assisted by skilled operators sent down by the makers of several of the machines. These girls were found to be capable of a good output on many of the operations after only a week's instruction. Lady superintendents are in charge of the place night and day, and a good mess-room is provided for meals. All the operations, with one exception, in the making of 18-pounder shells are carried out by the girls. The output on some of the operations exceeded expectation owing to the keenness of the girls, so much so that some of the machines provided have actually been found to be superfluous, and other machines have been shown to be capable of more work than had ever been believed to be possible. There is plenty of such labour available in the country, and all the women are moved by the keenest spirit of patriotism. We trust that employers will not hesitate to fill in their blanks from this source.

Motor barges, which stir up the mud and discharge large quantities of oil in the Grand Canal, in the neighbourhood of Ballinasloe, Co. Galway, will apparently soon bring about the extinction of some of the rarer aquatic mollusca. This at any rate is the opinion, founded on experience, of Mr. R. A. Phillips, who contributes a short but valuable account of the mollusca of South Galway to the *Irish Naturalist* for August.

OUR ASTRONOMICAL COLUMN.

Comet Notes.—Comet Mellish (1915 *a*) is moving north and towards the earth, and will be nearest about October 26 (47 million miles). It is also rapidly getting away from the sun, and its brightness is diminishing. J. Braae and J. Fischer-Petersen have extended the ephemeris given in *Astronomische Nachrichten* 4802. The comet is apparently moving nearly parallel to and only slightly S. of the line joining β Canis Majoris and β Orionis. It will make very close approach to each of these stars on September 27 and November 5 respectively. During this time its magnitude will have reduced from 7·7 to nearly 8·3. J. Braae also supplies a continuation of the ephemeris for the periodic comet Tempel II. (1915 *c*). Dr. H. Thiele, of the Bergedorf Observatory, publishes (*Astronomische Nachrichten* 4811), positions measured on August 9 and 10. It is now somewhat distant and retiring. Its declination is slowly decreasing on a path in Taurus, practically at right angles to that of 1915 *a*. For the other periodic comet at present in apparition, Winnecke's comet (1915*b*—this return was first observed by Dr. Thiele just mentioned), K. Hillebrand has extended the ephemeris given in *Astronomische Nachrichten* 4787, using slightly improved places (*Astronomische Nachrichten*, 4810). This comet has also passed perihelion, and does not come nearer than the sun's distance (about September 25). Its apparent path passed near κ Virginis (August 31), and from Virgo passes through Libra and centrally through Scorpio, bringing it near ϵ Scorpionis on October 4. During the last apparition (as 1909 *d*) it remained very faint and without observable tail or nucleus.

The Total Solar Eclipse, August 21, 1914.—Several publications dealing with this eclipse have lately come to hand. In one of these, MM. C. Benedicks and I. Fredholm describe (Ark. K. Svenska Vet' Acad., Band 10, No. 24) some photographs taken at Lundsvall with a telephoto combination (Goerz anastigmat and Zeiss teleansatz). They have devised a laboratory experiment reproducing the effect of shadow-bands which they ascribe simply to an effect of refraction in a non-homogeneous medium. Senor P. Carrasco forwards a reprint of a note referring to his observations made at Theodosia of the red line at λ 6373 (Revista R. Acad., Ciencas, January, 1915, Madrid). From Prof. Guglielmo Mengarini we have received a copy of an article which appeared in the *Nuova Antologia* (fasc. 1039, Rome), describing the operations of the Italian expedition to the Crimea. Although occupying a station in the neighbourhood of Theodosia, a fortunate break in the clouds permitted observations of totality, and the corona was photographed by Prof. Mengarini on a Lumière autochrome plate, exposed at the focus of the Fraunhofer equatorial (3 metres f. l.) loaned by Prof. Bemporad. Illustrations include reproductions of two composite corona photographs and some prominence pictures. Prof. Ricco made visual and spectroscopic observations. Prof. Palazzo employed a series of recording instruments in observations of solar radiation, terrestrial

magnetism, electric potential, and earth temperature. From the *Astronomische Nachrichten* (No. 4811) we learn that the 6-in. Repsold heliometer of the Leipsic Observatory was employed by Von Naumann, assisted by Frl. Kuschel, for measures of the position angles of the cusps at chronographically recorded instants through the greatest phase; 150 measures were obtained in about fifty-two minutes. The following corrections to the ephemerides were obtained:—

$$d\alpha = +11{\cdot}4'' \pm 0{\cdot}12'', \quad d\delta = -3{\cdot}6'' \pm 0{\cdot}08''.$$

The solar co-ordinates were taken from the *Berliner Jahrbuch*; the moon's position was derived from the Nautical Almanac.

COLOUR INDEX AND DISTANCE OF STARS.—Mr. P. J. van Rhijn, who has been working at the Mount Wilson Observatory, has presented an important memoir to the University of Groningen as thesis for doctorate dealing with the change of colour with distance and apparent magnitude, including a new determination of the mean parallaxes of the stars of given magnitude and proper motion. The stellar data employed in the paper are:—(1) Colour or photographic and visual magnitude; (2) spectral type; (3) distance. Colour and spectral type have been taken from the Yerkes actinometry. Distance has been determined according to Kapteyn's method of deriving mean parallaxes from proper motions and magnitudes, and then calculating the mean distances on the hypothesis that the logarithms of the ratio of true parallax to the most probable parallax of stars having the same magnitude and proper motion are distributed according to the law of errors. The data permitted these values to be satisfactorily obtained for the helium and second-type stars, but for the A-type paucity of parallaxes necessitated different treatment. As would be expected, Mr. van Rhijn has obtained results in good accord with those of Kapteyn, whilst the exclusion of stars with large angular motions is shown to be responsible for the opposed conclusions reached by Dr. Campbell.

Having obtained numerical expressions for the mean distances of the stars, Mr. van Rhijn proceeds to deal with the colour index. This has been taken as the summation of the effect of distance and apparent magnitude, the effect of absolute magnitude for various reasons having been given a zero coefficient. Out of the laborious calculations involved in the solution of the colour index equations the following results have emerged. The *faint* stars, and also the *distant* stars, are, *ceteris paribus, redder* than the bright stars and the near stars respectively. The increase of the colour index found being $+0{\cdot}025$m. $\pm 0{\cdot}004$ per cent. per unit of visual magnitude, and $+0{\cdot}00015$m. $\pm 0{\cdot}00003$ per cent. per unit of distance (parsec).

It is possible that the B stars and also the early A stars are immune from the distance effect. If that were so, the coefficient for the remaining spectral types would be increased to a value 6·5 times its probable error. The effect may be due either to an absorption of light in interstellar space or to an influence of absolute magnitude on colour.

RECENT STUDIES OF CERTAIN TROPICAL DISEASES.

MANY features of much interest are presented in the current number of the *Annals of Tropical Medicine and Parasitology* (vol. ix., No. 2, June 30). The opening article, by Dr. Breinl, deals with the ulcerative disease known as Gangosa, or Rhinopharyngitis mutilans, as observed by him in New Guinea. The causal agent of the disease is considered to be a new species of Cryptococcus (*C. mutilans*), of which illustrations are given in a coloured plate. The ravages due to Gangosa are forcibly demonstrated by three plates of photographs of different cases. The second paper, by Dr. H. Priestley, deals with *Theileria tachyglossi*, a protozoan parasite found in the blood and internal organs of an Echidna, *Tachyglossus aculeatus*, from the neighbourhood of Townsville, Queensland. This article is of interest as being the first record of the organism from marsupials. The parasite closely resembles *Theileria parva* of African East Coast fever in cattle. A coloured plate depicts the forms of the parasite observed.

The investigation into the causes of the prevalence of typhoid or enteric fever in Kingston, Jamaica, is ably set forth by Dr. H. H. Scott in the third paper. The mode of infection of food and milk supplies and the means of detection of unrecognised carriers of the typhoid bacillus are described, and should be of service to workers both at home and in the tropics. Water supplies and sewage disposal are also considered. The post-mortem findings and the results of cultivation of the bile from 120 consecutive autopsies are given in tabular form. Eighty more cultivations have since been made. From the total of 200 there have been six cases from which the bacillus has been isolated, apart from those subjects who showed post-mortem signs of enteric fever. There are also numerous charts showing the seasonal prevalence of the disease in Kingston.

Another paper by Dr. Breinl deals with the occurrence of various diseases prevalent on the coastal belt of British New Guinea. Eight plates of photographs illustrate the article. Certain diseases, such as malaria, are already known there, but less work has been done on others. Leprosy, filariasis, various curious fevers, juxta-articular nodules, yaws, tropical ulcers, contracting sores, destructive interdigital ulcers, and gangosa have been found among the natives. Only the regional distribution of the maladies has so far been attempted in any detail. New Guinea should provide a rich field for further research in tropical medicine.

The concluding paper is by Dr. Fantham, and deals with insect flagellates and the evolution of disease, with a plea for the recognition of the importance of comparative methods in the study of protozoology. The leishmaniases are used in illustration, and their origin from insect flagellates which are able to adapt themselves to life in vertebrates is discussed. The significance of the herpetomonad flagellate stage of Leishmania, and the existence of such a stage in man, at any rate in *L. tropica*, is indicated. The discovery of natural herpetomonads in mice by Dutton and Todd and by Fantham and Porter is recalled, as well as the occurrence of herpetomonads pathogenic to plants (Euphorbia spp.). The recent striking experiments of Laveran and Franchini on the introduction of herpetomonads into mammals, and of Fantham and Porter on the introduction of these flagellates into mammals, reptiles, amphibia, and fishes are summarised. In these experiments the evolution of the disease, that is, "leishmaniasis in the making," is revealed.

THE TALGAI SKULL.

PERHAPS the most remarkable incident of the meeting of the British Association in Australia last year was the demonstration given by Profs. Edgeworth David and Wilson to Section H in Sydney of a completely mineralised skull found in the neighbourhood of Talgai in the Darling Downs, Queensland. When war broke out and Prof. Wilson

had to devote himself to military duties, Dr. Arthur Smith was appointed acting-professor of anatomy in the University of Sydney, and Colonel Wilson most magnanimously handed over to him this most important human relic for investigation and description. With the valuable assistance of Mr. D. M. S. Watson he has succeeded in removing the matrix and fully exposing the extraordinary features of Australia's earliest known human inhabitant, perhaps a member of the earliest family to ferry across Wallace's line and tramp dogs through Papua to Queensland.

The skull has been purchased by the Hon. Joynton Smith, M.L.C., and presented by him to the University of Sydney. The formal presentation was made the occasion of a public meeting in the University on June 18, presided over by the chancellor, when Acting-Prof. Arthur Smith and Prof. David delivered addresses on the significance of the skull and its bearing upon the problems of man's antiquity in Australia.

Prof. David explained that the skull (of the Pleistocene period) was found after a flood thirty-one years ago in the bed of a creek near Talgai station, on the Darling Downs, by a stockman. From its highly mineralised state and mode of occurrence in a region where other fossil remains had also been found, the skull was of sufficiently striking geological antiquity to be grouped with the last ice epoch of the northern hemisphere. At the close of the last glacial period, gigantic animals became extinct, and probably the big animals known to have existed in Australia ages ago likewise died at the same time as those of the northern hemisphere. The discovery of the skull might serve to explain how it was that Australia, with its marsupial fauna, had an invader in the form of the dingo, which was a sort of Asiatic jackal, and "had no more right here than the Germans had in Belgium." There was the possibility of its having been brought here by early man. However, the skull was worth its weight in gold. The University of Sydney and men of science throughout the world were under a deep debt of gratitude to Mr. Smith for purchasing the skull, which was undoubtedly a priceless specimen.

Acting-Prof. Smith stated that the condition of the teeth was such as to show that the skull was a youth's, while at the same time it had many of the characteristics of an adult skull. The canine tooth of the Talgai fossil was the largest human tooth so far discovered. The extremely primitive characteristics were such as to warrant one claiming for the skull considerable importance in anthropology, and worthy of being placed with such specimens as the prehistoric Heidelberg jaw and the Piltdown skull. There was, he concluded, certain to be a great controversy concerning the latest discovery when the results of the investigation were made known.

THE RAINFALL OF JAVA.

LYING as it does midway between India and Australia, Java forms a climatological link between the two great British Dominions, and we recognise the appropriateness of the compliment implied in the choice of English as the second language in which this important outcome of Dutch enterprise is published. Tables are given of the mean monthly rainfall, number of rain days, and mean daily maximum rainfall (for each month) at 1061 stations in Java from observations taken between 1879 and 1911. Dr. van Bemmelen discusses the trustworthiness of the data, which are far from uniform. Obviously fallacious records have been eliminated, and there is reason to believe that the data here given compare well with those available for other tropical countries. Observations were made to the nearest millimetre, so that the critical rainfall which determines whether or not a day is to be counted as a rain day is 0·5 mm., or 0·02 in., *i.e.* four times the amount taken as determining a rain day in this country. As an example of the variability of monthly rainfall in Java, the case is cited of one station where in September, 1902, the rainfall was 12 mm., and in September, 1904, 896 mm. The greatest average annual rainfall recorded at any station in Java is 8305 mm., and the least 882 mm., but for both stations quoted the average was only for the short period of seven years, and experience shows that runs of seven years may occur with every year above or every year below the long-period average. The wettest year ever recorded at any station was 10,112 mm. at Sirah Kentjong, Kediri, in 1909, and the greatest fall in twenty-four hours was 511 mm. at Besokor, Semarang, on January 31, 1901.[1] Perhaps I may be pardoned if I remind those who keep metric and vulgar statistics in separate compartments of their brains that these figures are equivalent to 398·1 and 20·1 in. respectively.

The most important part of Dr. van Bemmelen's work is his series of maps of average rainfall. That he was fully alive to the difficulties in his way is made plain by his quotation of the reasons which deterred him in 1908 from making the attempt. To our mind the greatest difficulty, and one that has not been overcome, is the use of averages of varying lengths without reduction to a common period. We agree with the author that such reduction was difficult, if not impossible, in the circumstances, and that any sort of isohyetal map is better than none, and for many purposes, both scientific and economic, the maps he has produced will prove most useful. He gives a large-scale (1 : 1,000,000) map showing the position of the stations, and a series of smaller maps (scale 1 : 1,500,000) for annual rainfall, and the mean monthly rainfall of four selected seasons. These are:—(1) the mean of the three wettest months, December, January, February, when the west monsoon is blowing; (2) the mean for the two months March and April, showing the main transition; and (3) the mean for the two months May and June, when the transition is almost complete, to (4) the period of the east monsoon, represented by the mean of the three months July, August, September—the driest part of the year; finally, (5) the mean of October and November, showing the transition to the wet season again. These maps are admirably executed and most suggestive; but we are of opinion that both the climatic transitions and the geographical distribution would be more clearly suggested by maps based on the homogeneous average of, say, the last ten years, than on the data actually used. We are in hearty agreement with Dr. van Bemmelen's method of drawing isohyetal lines from such data as are available by what he aptly terms "a continual compromise between deduction and induction," the deduction being based on the recognised relationship between configuration, wind-direction, and rainfall, the induction being from the data which have been actually observed. Even where the data are as numerous, long-continued, and reasonably accurate as they are for the British Isles, the most probable distribution of rainfall can only be represented cartographically by such a "continual compromise."

HUGH ROBERT MILL.

[1] "Uitkomsten der Regenwaarnemingen op Java." (Results of Rainfall Observations in Java). By Dr. W. van Bemmelen. Pp. xxiii+173. Regenatlas (Rainfall-Atlas), vii maps. (Batavia: Javasche Boekhandel Drukkerij, 1914 and 1915.)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. A. J. BALLANTYNE has been appointed lecturer on ophthalmic medicine and surgery at the Anderson College of Medicine, Glasgow, in succession to Dr. A. F. Fergus.

MR. S. H. E. BARRACLOUGH, lecturer in mechanical engineering at the University of Sydney, N.S.W., has been appointed to the chair of mechanical engineering at the same University.

MR. P. H. FRAENKEL, at present in charge of the classes in electrical engineering at the Working Men's College, Melbourne, has been appointed lecturer in electrical engineering at the University of Western Australia, Perth, W.A.

IN consequence of the war, the winter session of most of the medical schools will be begun without any ceremony or opening address. At the Middlesex Hospital Medical School, however, Dr. J. Cameron will address the students on the opening day—October 1; at the University of Leeds, on the same day, Sir William Osler will deliver the inaugural address, and at the London (Royal Free Hospital) School of Medicine for Women, Mrs. Willey, M.D., will speak.

THE City of Bradford Education Committee has issued an abridged prospectus for the forthcoming session of the Bradford Technical College day courses. These courses of study are organised to provide (*a*) diploma courses, (*b*) part-time technical courses, and (*c*) courses for professional examinations. The diploma courses afford a full training for the various branches of the textile, chemical, and engineering industries, including the underlying sciences; they extend over three (or in some cases four) years, and occupy the full time of the student. Much of the work is of an advanced character, and a special feature is the great importance attached to scientific investigation. The courses provide the necessary training for the higher positions in works. Arrangements have been made with the University of Leeds whereby students of the University or of the college have the use of certain equipment and other facilities at both institutions. The part-time technical courses are intended for those students who arrange to spend part time in the works, or who attend the college for special sudy. The diploma of the college is awarded to each day student who has been in attendance for three complete sessions subsequent to passing the entrance examination, and who has passed the college examinations in *all subjects* of the diploma course taken. The diploma courses in chemistry, and in chemistry and dyeing, extend over four years.

BOOKS RECEIVED.

True Stories about Horses. By L. Gask. Pp. 266. (London: G. G. Harrap and Co.) 3*s*. 6*d*. net.

The Rare Earth Industry. By S. J. Johnstone. With a chapter on The Industry of Radioactive Substances, by Dr. A. S. Russell. Pp. xii+136. (London: Crosby, Lockwood and Son.) 7*s*. 6*d*. net.

The Human Side of Plants. By R. Dixon. Pp. xviii+201. (London: Grant Richards, Ltd.) 7*s*. 6*d*. net.

La Radiologie de Guerre. By G. Massiot and Biquard. Pp. viii+216. (Paris: A. Maloine et Fils.) 3.50 francs.

Proceedings of the Aristotelian Society. New series. Vol. xv. Pp. 441. (London: Williams and Norgate.) 10*s*. 6*d*. net.

Manchester in 1915: being the Handbook for the Eighty-fifth Meeting of the British Association. Pp. viii+120. (Manchester: University Press; London: Longmans and Co.) 1*s*. net.

The North-West Amazons. By Capt. T. Whiffen. Pp. xvii+319. (London: Constable and Co., Ltd.) 12*s*. 6*d*. net.

Structural Design. By Prof. H. R. Thayer. Vol. ii. Design of Simple Structures. Pp. ix+495. (London: Constable and Co., Ltd.) 16*s*. net.

Index of Economic Material in Documents of the States of the United States, New Jersey, 1789–1904. By A. R. Hasse. Pp. 705. (Washington: Carnegie Institution.)

Constructional Data of Small Telescope Objectives calculated at the National Physical Laboratory. By T. Smith and R. W. Cheshire. Pp. 32. (London: Harrison and Sons.) 2*s*. 6*d*.

The Wireless Telegraphist's Pocket Book of Notes, Formulæ, and Calculations. By Prof. J. A. Fleming. Pp. xii+347. (London: The Wireless Press, Ltd.) 6*s*. net.

Introduction to Magnetism and Electricity. By E. W. E. Kempson. Pp. viii+240. (London: E. Arnold.) 3*s*.

Ministry of Finance, Egypt. Survey Department. The Archæological Survey of Nubia. Report for 1909–1910. By C. M. Firth. Pp. 180+41 plates. (Cairo: Government Press.)

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THURSDAY, SEPTEMBER 16, 1915.

AGRICULTURAL TEACHING IN AMERICAN SCHOOLS.

The Essentials of Agriculture. By H. J. Waters. Pp. x+455+xxxvi. (Boston and London: Ginn and Co., 1915.) Price 1.25 dollars.

PRESIDENT WATERS tells us in his preface that the American people have decided that the public schools shall teach pupils "to think and to do," and shall give a training intimately related to the life the student expects to lead. As a necessary consequence agriculture figures largely in American schools, and we are told that wherever it is well taught it has proved to be a source of strength—whether the institution is a one-teacher country school, a high school, a college, or a university. The most successful method is to make the teaching local, taking the whole neighbourhood as the laboratory, and drawing abundantly on the local farms, gardens, orchards, and lanes, and the recognised local experts for the apparatus and materials required.

The teacher who embarks on such a course soon runs up against considerable difficulties, because none of the simple cases described in the popular book ever seem to occur in his own district; and, on the other hand, the problems in his district appear to be tantalisingly ignored by the book. It is indispensable, therefore, that the teacher's library shall contain only books by men of wide experience, and for this reason a special welcome is sure to be given to President Waters's book, for few men can claim to possess the necessary qualifications in greater degree.

The opening chapters set out briefly the principles on which the "new agriculture" rests. Under American conditions, where one or two men with modern machinery work a large farm, the man-yield is high though the acre-yield is low. Under European—including British—conditions the acre-yield is high, but the man-yield is low. What is wanted is a combination of the two. President Waters, therefore, proceeds to set out the conditions necessary for an increase in the acre-yield.

First of all, better plants and animals are needed. An account is given of the way in which improvements have already been effected in the common crops and live-stock, and the underlying principles are clearly set out. The author next discusses how plants feed and grow, and deals not only with plant food in the conventional sense but also with the water relationships of the crop, a subject to which American investigators have rightly paid considerable attention. This is followed by a section on soils, and emphasis is laid at the outset on the need for adopting a conservative policy. "We may be wasteful and careless of everything else," says the author, quoting William Brown, "but the land belongs to the Ages. We are trustees holding this land . . . and the happiness, the comfort, and the very existence of our children's children, and the millions who will follow, is dependent upon the conscientious, far-seeing wisdom with which we discharge this solemn trust." This high line is adopted by many of the most distinguished teachers of the United States, and is the key-note of much of the development work of recent years. The author follows Cyril Hopkins in working out his illustrations, and gives actual figures to show what quantities of nitrogen, phosphorus, potassium, etc., must be present in the soil in order to give a full crop. In Dr. Hopkins's experience the method works satisfactorily, although it has been the subject of much criticism. The quantities of these materials present in any ordinary soil are far in excess of the requirements of the crop, and it is necessary to assume that they are mostly in combinations unavailable for the plant, but that they become available at a certain rate per annum: 2 per cent. of the nitrogen, 1 per cent. of the phosphorus, and 0·25 per cent. of the potassium, being the rates quoted here. Naturally, a comparison can only be set up between soils of similar types under similar climatic conditions, but the actual procedure is much like the one that answers very well in this country, although based on a different principle.

The author next passes on to manures, and has much to say about the losses and wastage to which farm-yard manure is often subject. It is estimated that the amount produced in the United States each year is worth more than two billions of dollars, *i.e.*, more than the entire wheat or corn crop, and that nearly one-half is wasted. We ourselves are in no better case; the illustrations given by the author could be paralleled in this country. Fortunately the matter is being seriously taken in hand at Rothamsted and other experimental stations.

Individual crops and animals are then described, and the book closes with chapters on the business aspects of farming, and on mechanical power for farmers.

The book brings home vividly to the reader the enormous part played by the experiment stations in the development of American agriculture. The advances made during the last forty years would appear incredible if they were not accomplished

facts, and the book is so well written and so well illustrated that the student must see at once that the hope for the future lies in the close co-operation of farmers and experiment station investigators. Both in matter and in spirit it is entirely commendable. E. J. RUSSELL.

MOLLUSCS, MAMMALS, AND MEMORABILIA.

(1) *Our British Snails.* By the Rev. Canon J. W. Horsley. Pp. 69. (London: S.P.C.K., 1915.) Price 1s. net.

(2) *Land and Freshwater Mollusca of India, including South Arabia, Baluchistan, Afghanistan, Kashmir, Nepal, Burmah, Pegu, Tenasserim, Malay Peninsula, Ceylon, and other Islands of the Indian Ocean.* Supplementary to Messrs. Theobald and Hanley's Conchologia Indica. By Lieut.-Col. H. H. Godwin-Austen. Vol. ii. Part xii. December, 1914. Text. Pp. 311–442. Vol. ii. Part xii. December, 1914. Plates cxxxiii–clviii. (London: Taylor and Francis, 1914.) Price 25s.

(3) *Catalogue of the Ungulate Mammals in the British Museum (Natural History).* Vol. iv. Artiodactyla, Families Cervidæ (Deer), Tragulidæ (Chevrotains), Camelidæ (Camels and Llamas), Suidæ (Pigs and Peccaries), and Hippopotamidæ (Hippopotamuses). By R. Lydekker. Pp. xxi+438. (London: British Museum (Natural History), and Longmans, Green and Co., 1915.) Price 10s. 6d.

(4) *Nature and Science on the Pacific Coast. A Guide-book for Scientific Travellers in the West.* Edited under the auspices of the Pacific Coast Committee of the American Association for the Advancement of Science. Pp. xii+302+plates. (San Francisco: Paul Elder and Co., 1915.) Price 1.50 dollars.

(1) CANON HORSLEY'S clever little manual encourages food-thrift by pointing out that "all snails are edible and nutritious," even the garden snail being indeed "insipid; but as nourishing as calf's-foot jelly." Under the general heading of British snails it includes the slimy slug with scanty shell, and the aquatic bivalved pearl-bearing Unio. The statement that "there are but eighty-two land and forty-five freshwater shells in Britain" is slightly modified by the subsequent discrimination of forty-nine British freshwater species, including *Neritina fluviatilis,* for which, as recently shown, the generic name should preferably be de Montfort's Theodoxus. A gentle warning against the extirpation of rare species might have been added, to qualify the impulse to the study of natural history in general given by such remarks as the following: "If you want to make a collection, whether of dried plants, of insects, of shells, or of anything else, you must cultivate ways of order and method and neatness in the arrangement of your collection; and then your increased powers of observation, of comparison, and of method" will, the author believes, augment in you the virtues of prudence, justice, temperance, and fortitude.

(2) If you want to make a collection of books, and to cultivate order and neatness in the arrangement, what sort of temperate language will you apply to persons who publish the text of an important work in octavo and the plates in quarto? This is the afflicting arrangement in the otherwise admirable treatise on the land and freshwater mollusca of India. Doubtless the distinguished surveyor and veteran naturalist is responsible for the matter, not the form, of his book.

The book opens with a discussion of the Limacidæ, and a statement that "representatives of this family have not hitherto been described from the Himalayan range." But the bulk of this part xii. is concerned with a most industrious survey of the genus Alycæus, continued from Part vii., published in 1897. Here Col. Godwin-Austen notes that his outline of the sub-family Alycæinæ (vol. i., part v.) in 1886 now requires amplification because in the intervening twenty-eight years the number of known species has very greatly increased. That the members of the genus are not usually of gigantic size may be inferred from *Alycæus (Raptomphalus) magnificus* n. sp., since this magnificent and "very beautiful" species is less than a fifth of an inch, 4·25 mm., in its major diameter. Through quotation of original descriptions, intended to be exact, measurements are variously referred to mm., mill., in., unc., sometimes with rather confusing results. Thus *Alycæus cucullatus,* Theobald, is credited with a "Diam. maj. 21, diam. min. 20; alt. 21 unc.," and the notice that "This is a remarkably fine species." It certainly must be if it has a breadth of 21 inches and an equal height, but the figure magnified "×8," measures only 1⅝ in. across, with a height less than an inch. Even by a sprinkling of decimal points the dimensions cannot be harmonised with the illustration. Among matters of general interest, as apart from technical descriptions, special reference may be made to the discussion of *Alycæus (Cycloryx) graphicus,* illustrative of variation in shell-character in connection with distribution.

(3) By its title "Mollusca to Man," a well-known volume long ago hinted at a lowly lineage for humanity itself. This notice may therefore be excused for passing abruptly from slugs and snails to the graceful deer and ponderous hippo-

potamus with which the Museum catalogue of Ungulate Mammals is concerned in its fourth volume. This work closes the scientific career of Richard Lydekker. Its accuracy is guaranteed by the trusty supervision of Oldfield Thomas. The facile unwearying pen of its actual author writes no more. A preface by Dr. Harmer commemorates Lydekker's devotion to work, and the esteem in which he was held by his colleagues.

The volume has one feature challenging at least a note of admiration. It abounds in such names as *Moschus moschiferus moschiferus, Odocoileus virginianus peruvianus, Hylochœrus meinertzhageni meinertzhageni*! Surely "when ghost meets ghost" in the Elysian fields Linnæus will pertinently ask the newcomer, "Who is responsible for this violence to the serene simplicity of my binomial nomenclature?"

(4) "Nature and Science on the Pacific Coast," by thirty highly qualified writers, is a handbook of which it is not too much to say that quotations could agreeably and instructively fill many columns. Within a limit of fewer than 300 pages for the whole, each author has had to condense his wealth of information into the smallest possible compass. From the theory of earthquakes and the origin of petroleum to the war between benevolent bugs and pestilent scale-insects, from the history of the Panama Canal to the "influence of natural conditions upon legal and political institutions," nothing seems to have been forgotten. Geology and astronomy, flora and fauna, industries and amusements, have each their turn, with indices to literature for information beyond what can be compressed into a nutshell. Fishes receive more notice than mammals, and an extract from their record may be usefully quoted.

"Besides the trout and salmon, California has many other game fishes. First of these is the great tunny or leaping tuna, which ranges from 150 pounds to half a ton, and finds its greatest abundance about Avalon. This wonderful bay of Avalon has many other roving fishes, taken with the trolling spoon, such as the yellow-tail (*Seriola dorsalis*), the albacore (*Thunnus alalunga*), the yellow-fin, or Japanese albacore (*Thunnus macropterus*), and the huge bass called Jew-fish (*Stereolepis gigas*), with a head as large as a bushel basket—apparently nearly all head. The sword-fish (*Xiphias gladius*), and the Japanese spear-fish (*Tetrapturus mitsukurii*), are also sometimes taken off the Santa Barbara Islands.

"These noble fishes deserve protection from the amateur angler who catches a dozen or a hundred, has them hung up and photographed, himself beside them, then hires the guide to bury them while he goes away to have fun in his own fashion somewhere else."

THOMAS R. R. STEBBING.

AN ITALIAN TEXT-BOOK OF PHYSIOLOGY.

Human Physiology. By Prof. L. Luciani. Translated by F. A. Welby. Vol. iii.—Muscular and Nervous Systems. Edited by Dr. G. M. Holmes. Pp. x+667. (London: Macmillan and Co., Ltd., 1915.) Price 18*s*. net.

THE third volume of the English version of Luciani's "Human Physiology," translated from the Italian original published in 1913, deals with the general physiology of muscle, the mechanics of locomotion, phonation, and articulation, and the general and special physiology of the nervous system.

The chief characteristics of Luciani's work have already been referred to in the reviews of the first two volumes. The first chapter of the present volume gives an excellent account of the general physiology of muscle. The successive stages in the historical development of the subject are described with great clearness and unusual fullness. Although an admirable account is also given of the most recent work, further details regarding the physico-chemical theories of muscular activity might possibly have been included with advantage. Fortunately the bibliography given at the close of the chapter offers excellent guidance to students desiring fuller knowledge of the latter views. In the discussion of the nature of voluntary muscular contraction, no reference is made to the important results obtained by Piper and others with the aid of the string galvanometer. The use of the latter instrument has enabled these observers to analyse the discontinuous character of voluntary muscular contraction more accurately than was possible by means of earlier methods.

A very full and clear account of the mechanics of the locomotor apparatus is given in chapter ii. The subjects of phonation and articulation are discussed much more thoroughly in chapter iii. than in most English text-boks of physiology, and the editor has found some abridgment desirable in the interests of students.

An exceedingly interesting summary of the most recent work on the metabolism of the nervous system is given at the close of chapter iv. The remainder of the volume is devoted to the special physiology of the central nervous system, and of the sympathetic system. A brief review cannot do justice to the clearness and completeness of the presentation given by the author. The very full account of the physiology of the cerebellum has a special value as the work of one of the greatest authorities in this field.

The English rendering given by Miss Welby

shows the high qualities of lucidity and excellent literary style characteristic of her previous work. The value of the text-book for English students has been greatly enhanced by the additions to the bibliography, which have been made by the editor, Dr. Gordon Holmes. In conclusion it may be stated that the high level of excellence secured in the first two volumes has been well maintained, and leaves no doubt that the work, when completed, will be a most important and valuable addition to the English literature of physiology.

ELEMENTARY GEOGRAPHY.

(1) *A First Geography of the British Isles.* By W. M. Carey. Pp. vi+169. (London: Macmillan and Co., Ltd., 1915.) Price 1s. 6d.

(2) *Bacon's Sixpenny Contour Atlas.* North England Edition. Pp. 41. Southern Wales Edition. Pp. 41. Lancashire and Yorkshire Edition. Pp. 41. (London: G. W. Bacon and Co., Ltd., n.d.) Price 6d. net each.

(1) THIS book has been written for classes preparing for preliminary or junior local examinations of the universities; it begins by considering latitude and longitude, and the climate of Britain is not considered until the last chapter; all this means that a good deal of previous reading and learning is presupposed. There is a large amount of information, much of it interesting and "curious," and it is markedly accurate; but the comparison of particulars and progression in idea which might be expected in a volume of a "First Book of Science" series are largely absent.

Of the eleven chapters which the book contains, eight deal with the geography of as many different regions, while the two first and the last deal with Britain as a whole. An excellent feature is that each chapter is preceded by about half a dozen practical exercises, and is followed by a similar number of questions partly taken from public examinations and partly original. The practical exercises probably supply the reason why the book is included in the series; but it may be doubted whether there are not too many of the type in which the lengths of certain rivers are given in miles and the pupil is asked to draw lines to represent those lengths to scale. As a means of keeping the youngsters quiet this is good, but the geographical value of the work is small, and it does not help them to remember the relative lengths. Notwithstanding its excellent qualities, we are disappointed with the book. The impression is that there are very many facts, but important and unimportant alike appear to receive the same attention.

The index would have been more useful had it been complete; on a page taken at random nine names were indexed and a dozen were not.

With (2) on the market in its several editions, no school, however straitened, can plead that it cannot afford a satisfactory atlas because of the cost. There are few other atlases on the market which at the price are possible rivals. Each edition contains four local maps, showing communications, geology, relief and vegetation, twenty-four regional relief maps, and seven world maps. It is a pity that some of the work is rather rough; in the Lancashire and Yorkshire edition the Aire Gap is shown on one map to be all under five hundred feet, on another map a small part is shown just over five hundred feet, while in a third the greater portion is shown as more than five hundred feet.

OUR BOOKSHELF.

Citrus Fruits. By Prof. J. E. Coit. Pp. xx+520. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1915.) Price 8s. 6d. net.

THIS work is written by the professor of citriculture of the University of California, where he is also superintendent of the University Agricultural Experiment Station with regard to citrus fruits. The first chapter deals with the history and development of the citrus industry in California from the introduction of European fruit trees and vines by Spanish Jesuit missionaries about 1701, and traces the industry to the present time, recording the assistance to its upbuilding rendered by the Department of Agriculture, the University of California, and the Chambers of Commerce, which have aided by lectures, experiments, and advertisement, leading up to the practical result, namely, the shipment of 60,000 carloads of fruit in 1914.

The following chapters deal with the geography and climate of California; the botany of citrus fruits, their varieties and origins; improvement of varieties by breeding, and from "sports"; judging fruits; site and preparation for planting; cultivation, manuring, cover crops; irrigation; pruning and top-working; frost and orchard heating; picking and packing; blemishes and their prevention; manufacture of by-products (citric acid, candied fruit, etc.); marketing; cost and returns; diseases and their control; insect control and fumigation; horticultural inspection and quarantine; legislation.

Budding, even of old trees, is found more successful than grafting. Some of the best varieties of orange (Navel) and lemon (Eureka) are parthenocarpic, and can successfully be planted in large blocks, but most varieties require cross-pollination, and some varieties are found not to be congenial pollenisers.

The author considers the selection of "sports" a more likely source of valuable varieties than by hybridising and raising new sorts.

The above are a few selected facts of interest, but the book will be found interesting even in a country where the orange is not commercially grown, and invaluable where citrus fruits are a staple industry. CECIL H. HOOPER.

Lessons in Elementary Physiology. By Dr. T. H. Huxley. Enlarged and revised edition. Pp. xxiv + 604. (London: Macmillan and Co., Ltd., 1915.) Price 4*s*. 6*d*.

PROF. HUXLEY'S "Physiology" was a masterpiece; it first appeared in 1866, and since that date has been easily first among a crowd of elementary manuals. The edition which appeared before the present one was issued in 1900, and was then edited by Sir Michael Foster and Dr. Shore. It has been frequently reprinted since that date, but after a lapse of fifteen years the publishers have very rightly judged that it required revision in order to incorporate the new facts and generalisations which have been discovered in the meantime. This work has been entrusted to Mr. Joseph Barcroft, of Cambridge, and he has fulfilled his task with ability, tact, and, one may add, reverence. Although the repair has been substantial, one cannot but be struck with the fact how much of the fabric is left intact. There could be no better testimony to the thoroughness and permanence of the labours of the original builders. The main principles of physiological science remain for the most part unchanged. With some notable exceptions, recent physiological progress has been concerned with details, which are interesting enough to the researchers, but are really not essential from the elementary student's point of view. We wish the present edition every success and a continuance of usefulness. W. D. H.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Remarkable Nest of "Vespa norwegica," and Fertility of Workers of this Species.

THE following observations on a colony of *Vespa norwegica* are perhaps deserving of record. About the middle of July a relative living at East Liss, Hants, endeavoured to take for me a nest of this tree-wasp, but was forced to beat a retreat after merely bending the branch of the rhododendron to which the nest was attached. The effect of this bend was to throw the nest permanently out of its original position, and to incline the combs within it at a considerable angle to the horizontal plane in which they had, as always, been built. On July 28 the nest was successfully captured, and forwarded to me, together with such of its inmates as happened to be at home at the moment of capture. The combs were five in number; the three upper were each of about four inches in diameter; the fourth smaller and of irregular shape, there being a patch of small, misshapen cells placed obliquely on one margin. The position of the fifth comb was very remarkable; it was attached, not to the fourth, but to the third comb; and, moreover, instead of hanging parallel to the other combs, it was set at a decided angle to them, the angle being such that it lay in the true horizontal plane, from which the others had been displaced. It is thus evident that the worker wasps are able to discriminate between oblique and horizontal positions with some nicety. This fifth comb had obviously been built since the disturbance of the nest; it consisted of but twenty-five small, though regularly hexagonal cells, and it is probable that the patch of irregular cells added to the edge of the fourth comb was of similar date, and represents an attempt to regain the horizontal plane for that comb. The queen had also been affected by the disturbance of the nest, for she had laid two, and frequently three, eggs in many of the cells of the second and third combs, instead of the normal one egg only. There were no eggs in any of the cells of the oddly-placed fifth comb, nor in the patch of irregular cells on the edge of the fourth. The absence of eggs from these cells points to all workers being sterile up to the time when the nest was taken. Within the nest as I received it were several dozen drones, two workers, and the queen; the majority of the workers must have been afield when the nest was removed.

On August 24 I visited the bush whence the nest was obtained, and found that the workers had continued operations, although bereft of their queen. On the ground immediately beneath the place of the original nest they had built an irregular mass of wasp-paper round some dead twigs of heather, and in the midst of this mass, smothered in the wasp-paper wrappings, was a very small comb consisting of six badly-shaped cells, of which two contained eggs that had failed to develop and had shrivelled. But fastened to a branch about a foot above this mass was a small nest of normal shape, and of about two and a half inches diameter, such as might be expected in early summer. Worker wasps were visiting both these structures, and occasionally one would emerge from the nest and proceed direct to the mass upon the ground, or *vice versâ*; both were clearly the work of the one colony. I caught all the wasps—only thirty-seven in number—and found them to be workers without exception. Inside the suspended nest was one small, but perfectly regular comb composed of forty-four cells, thirty-three of which contained larvæ of various sizes. None of these larvæ looked healthy or well nourished, and three of the largest were dead and had turned pink. There was no queen in the nest; hence it is certain that at least one of the workers must have become parthenogenetically fertile.

It is probably not unusual for workers to become fertile in strong colonies towards the end of a favourable season; but I am not aware that such clear proof of worker fertility has hitherto been obtained, and it is certainly singular that reproductive powers should arise in the circumstances above narrated.

OSWALD H. LATTER.

Charterhouse, Godalming, September 7.

An Original Representation of the Giraffe.

AMONG the interesting reproductions of early figures that Prof. Eastman has lately presented to the readers of NATURE are two of the giraffe—one (NATURE, February 18) from Ehrenberg's memoir published in 1834, and the other (July 29) from a manuscript in the British Museum. Both these figures are attributed to Thebes; the former, from a "monument," is shown with a monkey-like animal on the back of its neck, and the latter, from a "tomb," has the monkey in

front of the neck. In both cases the giraffe faces towards the right, and there can be little doubt that they are efforts of our recent ancestors to try to copy an ancient picture.

G. A. Hoskins published his "Travels in Ethiopia" in 1835; consequently his animal figures are entitled to rank as early representations, though they were not done with zoological intent. A feature of the work is a series of colour-printed plates showing an expedition returning from the land of Punt, and among the figures appears to be the original of Prof. Eastman's giraffes. The accompanying illustration (Fig. 1), due to the skilled hand of Mr. W. Ashton, serves to show the delicate accuracy of Hoskins's copy, which must in its turn be very closely similar to the Egyptian painting. Attention may be directed to the prehensile lips, the form of the shoulders, and the tuft of hair at the end of the tail. The colouring of Hoskins's plate enhances the accuracy of the details. The giraffe is only an item, and, like the elephant in the same procession, is evidently a young animal, as it is only a little taller than the men in charge of it. The painting includes the leopard, hunting cat, ibex, dogs, cattle, and a curious bear-like animal, the portrait of which is probably as true to life as the others. Four distinct races are shown among the human figures who are carrying elephants' tusks, ostrich feathers and eggs, and skins of different kinds, as well as many other treasures from the southern lands.

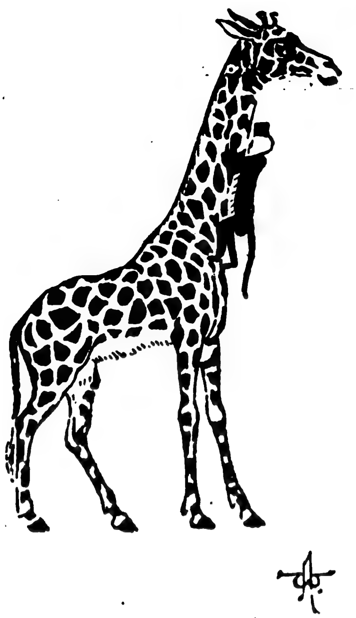

FIG. 1.—Illustration of giraffe. From Hoskins's "Travels in Ethiopia."

Hoskins states that the original painting was in a tomb of the time of Thothmes III., but excavation had not then proceeded far, and possibly the structure is what we now know to be the west terrace of Queen Hatshepset's temple of Der el Barhari. Here, according to Dr. E. A. Wallis Budge's description, there are bas-reliefs that must be very similar to, if not identical with, the painting copied by Hoskins. The expedition to Punt was a feature of Queen Hatshepset's reign, and occurred about 1600 B.C., while the association of Thothmes's name is accounted for by this gentleman's habit of substituting it for that of his predecessor.

G. W. GRABHAM.

Khartoum, August 21.

THE WORLD'S SUPPLY OF POTASH.

IN view of the scarcity of potash occasioned by the war, the Imperial Institute has issued a pamphlet (pp. 47, price 1*s*.) under the above title, in which a review is given of the existing sources of supply and suggestions made as to the possibility of obtaining potash from materials not hitherto worked for this purpose. The potash used in this country has been almost exclusively derived from the Stassfurt deposits, south of Magdeburg, which have been so systematically and economically worked since about 1862, that German potash, on account of its cheapness, has driven all other competitors from the market. Potash salts are essential constituents of plant food, and the greater part of the potash salts extracted at Stassfurt is used as a fertiliser; but relatively large quantities are employed in various chemical industries and in the manufacture of glass and soap.

Besides the Stassfurt deposits, there is only one extensive deposit of carnallite at present known, and that is the Spanish deposit of Catalonia, the working of which, it is stated, has recently been commenced. This deposit has great commercial promise, and, next to those of Stassfurt, may prove to be the most important source of potash at present known. There are also deposits in India, which may prove to be of importance if they can be worked sufficiently cheaply.

All plants contain more or less potash, and the utilisation of the ash of wood, the ash of seaweeds, of beetroot residues, and similar by-products of industries in which vegetable raw materials are employed, is of importance as a source of potash, especially at a time of scarcity like the present. The burning of seaweed and the extracting of potash from the ash, at one time an important industry on the coasts of Scotland and Ireland, has recently shown signs of revival. From Ireland during 1913, 3939 tons of kelp, valued at 16,631*l*., were exported. As a rule the Irish kelp contains more potash than that produced in Scotland. At the present time the utilisation of the giant kelps of the Pacific coast is regarded by many as the most promising source of soluble potash salts in the United States. The best account of the new industry which has sprung up on the Pacific shores was given by F. K. Cameron in a paper read before the Franklin Institute in 1913 (Journ. Franklin Institute, vol. clxxvi., p. 347). According to an official estimate 6,000,000 tons of potassium chloride could be obtained annually from this source. It was shown by Balch in 1909 that the giant algæ of the Pacific, the principal species being Nereocystis and Macrocystis, contain about five times as much potash as the majority of seaweeds, the average percentage on the dried weed being from 15 to 20 per cent. of K_2O. Since the publication of these results various labour-saving devices have been tried for cutting and collecting the weed, and the cost per ton of weed now landed is stated to be about 20 cents.

The preparation of potash salts and iodine has also become an important industry on certain parts of the coast of Japan, and it is stated that Japan now supplies about 80 per cent. of the iodine consumed in the United States. The weeds used on the coast of Japan are species of Laminaria, *Ecklonia cava, E. bicyclis,* and Sargassum, spp.

In Canada the burning of wood to ash was for several years a considerable source of potash, but

in a report recently issued by the Forestry Branch, Department of the Interior, it is stated that at the present day, owing to altered conditions, there is small possibility of reviving the potash industry as formerly practised. The amount of potash to be recovered from the waste from the sawmills is considered to be too small to be regarded as commercially practicable for the mills to undertake its recovery. In most cases the only use for the ash from sawmill burners is for the farmers in the locality to apply it directly on the land.

Experiments made at Rothamsted recently have shown that the ash of hedge cleanings, consisting of grass, weeds, and clippings, contained on the average about 11 per cent. of potash, that is to say, about as much as kainit (Russell, Journ. Board Agric., 1914, vol. xxi., p. 694). The potash is present in a very soluble form (carbonate) and is rapidly washed away. If it is to be utilised, therefore, care must be taken to protect the ashes from showers of rain while they are cooling.

A rather neglected source of potash is the soapy water used for removing grease from wool. The matter soluble in water contains potash equivalent to 5 per cent. of potassium carbonate, calculated on the raw wool, but as the recovery of potash is not remunerative unless conducted on a large scale, the wool washings are usually allowed to go to waste. On the other hand, in Belgium, France, and Germany the wool suint is utilised as a source of potash; it is estimated that in the Roubaix district alone potash salts to the value of 100,000*l.* are obtained annually from this source.

One of the most promising future sources of potash supplies seems to be the recently discovered deposits in Alsace. In 1904 deep borings were made at Niederbruck in the hope of striking oil, but instead saline matter was encountered at the depth of 1174 ft. Since then the number of mines has increased to twelve; in 1912 the output was 137,243 metric tons, and in 1913, 350,341 metric tons. Recent reports state that the Alsatian deposits are probably continued across the Rhine into Baden.

During the past few years attention has been directed to the possibility of employing as manures, with or without previous treatment, minerals which contain potash in an insoluble form; the more important of these are alunite, felspar, and leucite. An account is given in the pamphlet of the methods which have been experimented with.

W. A. D.

PROF. D. T. GWYNNE-VAUGHAN.

AFTER completing barely one year of duty in the chair of botany at Reading, Prof. Gwynne-Vaughan died on September 4. He was only forty-four years of age, but he had made a solid position for himself as a plant anatomist, and he had already shown his capacity as a teacher and a director of research. A life not only of promise, but also of notable achievement has thus come to a premature close.

Born in 1871, at Llandovery, he was educated at Monmouth School, whence he passed as scholar to Christ's College, Cambridge, and took the Natural Sciences Tripos. After graduation he held a mastership for a time, but soon relinquished it to pursue research. For this end he went to the Jodrell Laboratory, Royal Gardens, Kew, which was then under the directorship of Dr. D. H. Scott. Here his investigations of stelar morphology began, and in 1897 he published his first results on Nymphæaceæ (Trans. Linn. Soc.) and Primulaceæ (*Annals of Botany*). A peculiarly lucid preliminary statement at the British Association at Liverpool (1896) led to his appointment as assistant in botany in the University of Glasgow, where he worked for about ten years, laying the foundation of his unrivalled knowledge of the anatomy of the Pteridophyta. In 1907 he became head of the department of botany in Birkbeck College, London, but after two years he was appointed professor of Botany in Belfast. Finally, in 1914, he took up similar duties at Reading. In 1911 he married Dr. H. C. I. Fraser, herself an accomplished botanist, who had succeeded him in the post at the Birkbeck College.

He acted for several years as secretary and afterwards as recorder of the botanical section of the British Association, winning the warm regard of all its members. His funeral occurring on the opening day of its current session in Manchester, the business of the section was by common consent suspended during the time of the service.

Gwynne-Vaughan's position as an anatomist is based, not only on his published works, but also upon a great accumulation of well-assured facts recorded in notes, which he readily made available to his colleagues. He was chiefly interested in stelar problems relating to the Filicales. From the list of his works two series of papers may be mentioned as of outstanding importance. The first includes the two memoirs on solenostelic ferns (*Ann. of Bot.*, 1901, 1903), in which he established the method of representation of the vascular system in the solid, as reconstructed from sections. The second series was written in happy co-operation with Dr. Robert Kidston, and dealt with the fossil Osmundaceæ (Trans. R.S. Edin., 1907–1911). Seldom have two minds blended their results more effectively. The one brought to bear a wide knowledge of fossils from the stratigraphical and systematic point of view. The other supplied critical and expert anatomical experience, based upon study of living plants. The result is a series of beautifully illustrated memoirs, which trace in a natural sequence of plants an anatomical progression which follows most convincingly the successive stratigraphical horizons. They also indicate the underlying method of that progression which finds its reflection in other series of vascular plants. Already these memoirs may be held to have taken their place among the botanical classics.

Work of such a nature already achieved makes

the more acute the loss of Gwynne-Vaughan at a relatively early age. To his colleagues he was most loyal and helpful. His own results were always strictly tested and criticised. The consequence will be that they will be durable, and take permanent place in the web of botanical science.

F. O. B.

THE BRITISH ASSOCIATION AT MANCHESTER.

THE British Association this year was favoured with exceptionally fine weather. The sun shone all day long, and not a drop of rain interfered with the visits to works and the short sectional excursions to places of scientific interest. The number of members and associates (1438), although satisfactory in the circumstances of a great European war, was small as compared with previous meetings. From these two factors it might have been anticipated that the attendances at the sections would be unsatisfactory. But from all accounts that have been received the section rooms have been well filled both in the morning and afternoon sittings, and the proceedings have been of quite exceptional interest and importance. It is evident, therefore, that the modifications of the usual programme that were made for the Manchester meeting have affected those who attend the association for the sake of the excursions and social functions far more than those who regard it seriously as an opportunity for scientific work and exchange of ideas.

It may be a question for the serious consideration of the council whether the Manchester model (1915), as it may be called, is not one which should be followed in future meetings of the association; but it may be said, without fear of contradiction, that the decision of the local executive committee to repeat its invitation, after the declaration of war, has been fully justified.

The reception by the Lord Mayor in the School of Technology on Wednesday evening was the only general social function of the week, but being fixed on the second day of the meeting it gave a welcome opportunity to members to meet their friends as well as to inspect the machinery, appliances, and lecture-rooms with which this great institution is equipped. The arrangements made by the committee for the visits of members to factories, warehouses, municipal undertakings, and various places of special interest in Manchester and district worked well, and the short excursions were well attended. The citizens' lectures given in Manchester and other towns in the neighbourhood attracted large audiences.

The meeting may be pronounced a decided success, and the vote of thanks to the local executive committee moved by the president at the concluding meeting on Friday evening was very heartily accorded.

Next year's meeting is to be held at Newcastle, under the presidency of Sir Arthur Evans, but final arrangements will not be made until about next March. The place of meeting in 1917 is to be Bournemouth.

Subjoined is a synopsis of grants of money appropriated for scientific purposes on behalf of the general committee at the Manchester meeting just concluded. The names of members entitled to call on the general treasurer for grants are prefixed to the respective committees. Reappointed committees are starred, and it will be noticed that of the forty-one committees receiving grants, only five are new.

Section A—Mathematical and Physical Science.

	£	s.	d.
*Prof H. H. Turner—Seismological Observations	130	0	0
*Sir W. Ramsay—Tables of constants ...	40	0	0
*Prof. M. J. M. Hill—Mathematical tables	35	0	0

Section B—Chemistry.

	£	s.	d.
*Prof. H. E. Armstrong—Dynamic isomerism	20	0	0
*Prof. F. S. Kipping—Aromatic nitroamines	10	0	0
*Mr. A. D. Hall—Plant enzymes	10	0	0
*Prof. H. E. Armstrong—Solubility phenomena	5	0	0
*Prof. H. E. Armstrong—Eucalypts ...	30	0	0
*Prof. Orme Masson—Influence of weather conditions on nitrogen acids in rainfall and atmosphere	20	0	0
*Prof. W. J. Pope—Crystalline form and molecular structure	10	0	0
*Dr. F. D. Chattaway—Non-aromatic diazonium salts	8	10	0
Sir J. J. Dobbie—Absorption spectra, etc.	10	0	0

Section C—Geology.

	£	s.	d.
*Prof. Grenville Cole—Old Red Sandstone rocks of Kiltorcan	7	0	0
*Prof. W. W. Watts—Critical sections in Palæozoic rocks	20	0	0
*Prof. P. F. Kendall—List of characteristic fossils	10	0	0
Dr. J. Horne—Old Red Sandstone rocks at Rhynie...	25	0	0
Dr. R. Kidston—Lower Carboniferous flora at Gullane	8	0	0

Section D—Zoology.

	£	s.	d.
*Dr. A. E. Shipley—Belmullet Whaling Station	25	0	0

Section E—Geography.

	£	s.	d.
*Sir C. P. Lucas—Conditions determining selection of sites and names for towns	15	0	0

Section F—Economic Science and Statistics.

	£	s.	d.
*Prof. J. H. Muirhead—Fatigue from economic standpoint	40	0	0
*Prof. W. R. Scott—Industrial unrest ...	20	0	0
*Prof. W. R. Scott—Women in industry	90	0	0
*Prof. W. R. Scott—Effects of war on credit, etc.	25	0	0

Section G—Engineering.

	£	s.	d.
*Prof. J. Perry—Complex stress distributions	40	0	0
*Dr. Dugald Clerk—Gaseous explosions	50	0	0
Dr. H. S. Hele-Shaw—Engineering problems affecting prosperity of the country	10	0	0

	£	s.	d.
Section H—Anthropology.			
*Sir C. H. Read—Age of stone circles ...	25	0	0
*Prof. G. Elliot Smith—Physical characters of ancient Egyptians	15	0	0
*Dr. R. R. Marett—Palæolithic site in Jersey	25	0	0
*Prof. J. L. Myres—Archæological investigations in Malta	10	0	0
*Prof. J. L. Myres—Distribution of Bronze age implements	5	0	0
Section I—Physiology.			
*Sir E. Schäfer—Ductless glands ...	20	0	0
*Prof. C. S. Sherrington—Mammalian heart	20	0	0
Section K—Botany.			
*Prof. F. O. Bower—Cinchona Station, Jamaica	12	10	0
*Prof. F. W. Oliver—Structure of fossil plants	2	0	0
*Prof. F. F. Blackman—Heredity ...	45	0	0
Section L—Education.			
*Prof. J. A. Green—Museums	15	0	0
*Dr. G. A. Auden—School books and eyesight	5	0	0
*Dr. C. S. Myers—Mental and physical factors	20	0	0
Mr. C. A. Buckmaster—"Free-place" system	10	0	0
Corresponding Societies Committee.			
*Mr. W. Whitaker—For preparation of report	25	0	0
Total	£968	0	0

CONFERENCE OF DELEGATES OF CORRESPONDING SOCIETIES.

OPENING ADDRESS BY SIR THOMAS H. HOLLAND, K.C.I.E., D.Sc., F.R.S., PRESIDENT OF THE CONFERENCE.

The Organisation of Science.

AMONG the many lessons we learn in every great war, there is always one that stands out prominently as something of fundamental and national importance. In the Crimea our shortcomings in commissariat organisation were demonstrated with painful emphasis. In South Africa we learnt something of the way in which the initiative of the individual, naturally more prominent in the amateur soldier, triumphs, in unforeseen circumstances, over any system fixed by formal and traditional discipline. The great war now in progress will result more completely than any of its puny predecessors in recasting our national ideas, economic, political, and military.

Of all the lessons we are likely to learn, the one that so far promises most to affect the life of the nation may be summed up in a word, *organisation.* The fuss made lately about the shortage of munitions; the discovery in the ranks of the Army and among its officers of thousands who are only amateur fighters but are professionally trained technologists; the recasting of the Cabinet; the introduction, twelve months after the commencement of the war, of legislation to register and classify the technical qualifications of the people; the repeated occurrence of coal strikes on a large scale, settled only by the intervention of Cabinet Ministers, and by an obviously temporary compromise, are all confessions of our shortcomings in national organisation—shortcomings that have already cost the country thousands of lives.

On the other side of the "front" we see organisation raised to the level of a national cult—*Kultur*—with the result that, while efficiency in action and economy in the utilisation of a country's resources have been raised to a standard hitherto unknown, and by us undreamt of, the human instincts have been drilled out of existence, and Germany stands alone as an almost perfect machine in action, but, like a machine, unable to understand the rest of the human race; admired for its mechanical efficiency, but loathed for its degradation of the great human instincts of liberty and toleration.

But between these extremes there must be a course of maximum wisdom; for admittedly both the organisation of the community (the feature which is supposed to dominate the professional classes) and freedom of the individual (the prerogative of the amateur) are necessary for the progress of what is best in civilisation.

Every meeting of the British Association reminds us that early in the last century a body of learned men realised that the form of study popularly known as scientific needed organising, required the strengthening influence of a protective guild—the formation of a cult—in order that its value might be forced on the popular mind. Long before the foundation of the British Association a comparatively small number of men had interested themselves in scientific problems, and their work had so far progressed as to require specialisation, with the foundation of distinct societies. This specialisation found expression at the first three meetings of the association by the formation of committees for (i) Mathematics and General Physics; (ii) Chemistry and Mineralogy; (iii) Geology and Geography; (iv) Zoology and Botany; (v) Anatomy and Physiology; and (vi) Statistics.

These six groups have developed into our present twelve sections and extra subsections, and in practice every section, by classification of its papers and in the conduct of its discussions, acknowledges a further specialisation that is none the less real because it has not been yet formally recognised in organisation.

It is difficult for us to realise that, although the collection of scientific data and thought had made such progress eighty-four years ago as to require the subdivision indicated by the first institution of the British Association, the importance of science was still scarcely recognised among the so-called learned and ruling classes. Obvious if insufficient progress had been made since the days when it was possible for Dean Swift to issue, as tolerable literature, his satires on the Royal Society, or for Robert South to add to his doubtful popularity by describing its members as incapable of admiring anything except "fleas, lice, and themselves."

Although science now takes its place on equal terms with literature in the world of academic culture, we have so far succeeded only to a very small extent in getting the professors of pure science to co-operate in unison with the captains of industry who depend entirely, consciously or otherwise, on the application of scientific laws to industrial problems.

There has hitherto been a tendency for scientific and literary men to gather together under one banner, with the motto "learned," but a more natural association should be indicated by the community of interests between scientific men and technical experts. The student of pure science often discovers laws or formulates theories which are but accidentally carried beyond the purely intellectual world. On the other hand, technical experts frequently work by empirical methods that are discovered either by accident or as

the result of many costly blunders. The growth of science and of commercial technology has been largely independent and unrelated, that is, without organisation.

The absence of this organisation has shown itself for many years to those who are able to read the signs of the times, by the way in which German applied science has assisted commercial activity in trespassing on markets created and formerly occupied by British enterprise. The result of organised co-operation on one hand and of disconnected effort on the other, has now been brought home to us all, suddenly and painfully, by the war. In the utilisation of technical science the German army has had an enormous advantage for which we have had to pay by the lives of some of our best officers and men.

In Germany the scientific, technical, and commercial community (not communities) is mobilised, and each individual in it has been given his appropriate function. In this country, on the other hand, we still have endless instances of right men in wrong places, while scientific activity seems to be devoted to the voluntary formation of innumerable and often irresponsible committees, with overlapping functions and with no apparent common aim in view. Nothing could more clearly demonstrate our shortcomings in organisation than the columns of the daily Press, which are filled with complaints from scientific men who, though among the most distinguished in the world of pure science, are, in this great struggle, still unemployed, and unfortunately often show by the tone of their complaints that they are also unemployable.

A small fraction of the time now devoted in this country to discussion in committee would be sufficient, if turned to well-directed effort, to remove many of the handicaps from which our Navy and Army are now suffering in this critical stage of the war. Most committees might be justifiably likened to two athletes at the east end of a church, discussing the better route by which to get around to the tower, while a cripple starts off at once by one of the routes (possibly even by the less easy of the two); yet the cripple gets there while the athletes are still wrangling.

The root trouble with us is due to the fact that our committees are generally composed of members appointed, not because they are the best able to solve the problem in hand, but because they represent vested interests, and vested interests have now grown to dimensions beyond power of removal, because our institutions are often the products of worthy local, unconnected and therefore unorganised, effort. In their relations to one another, institutions that profess a common public aim show a spirit of jealous competition more prominently than any community of ideal. One cannot study the recent history of university education in London without being painfully impressed with the fact that internal friction in a machine without design results in a consumption of energy that costs more than the educational output is worth.

Our scientific and technical societies similarly suffer from overlapping and conflicting interests, and this conference will be of some value if, instead of discussing for once some special scientific problem, its members become inspired with a desire to direct the activities of the societies they represent so as to reduce the quantity of machinery; to correlate their activities with those of the metropolitan institutions with headquarters in London; to subdivide those institutions composed of dissimilar elements, and to assist, so far as practicable, the regrouping of those who work with common data and with a common aim.

An excellent illustration exists of the way in which reform of this kind is possible when members are sufficiently public-spirited to distinguish between the wider interests of science and those of their own special societies. Up to 1889 there were in this country about eight separate societies devoted to the technical interests mainly of coal mining. In that year four of these societies federated their interests, and during the few following years three others joined the federation and pooled their resources to meet the cost of a common publication and to maintain a common office at Newcastle.

In 1892 the Institution of Mining and Metallurgy was founded in London to meet the wants of technologists devoted mainly to the requirements of metalliferous mining. The rapid growth of this institution, its metropolitan location, and its comprehensive name, challenged the premier position of the Federated Institution of Mining Engineers. The latter consequently changed its name to *The* Institution of Mining Engineers, and moved its central office to London. Thenceforward each institution, not only published papers on its own special branch of mining, but trespassed frequently on the natural domains of its competitor. Later, when one of these institutions applied for a Royal Charter, the other in its own interests successfully opposed the application.

But in 1913, through the happy possession of two presidents who could distinguish parochial from national interests, both institutions agreed to a delimitation of their spheres of influence, and each supported with success the petition of the other for a Royal Charter. They are now no longer competitors, but sister institutions, and, instead of competing for recruits, they can afford to define and maintain a high standard of technical qualification and professional etiquette for the British mining engineer.

One of the first principles observed by a student of science is that of classification. Classification means not merely the bringing together of things that are similar in some essential feature; it also means the separation of those that are essentially unlike, although superficially bearing some form of resemblance.

One realises how hard it is to apply the pruning knife of scientific classification when one contemplates the spectacle of various "literary and philosophical societies" which still survive, mostly under financial difficulties, in many of our large provincial cities, vainly endeavouring to cover "the whole realm of nature." Such societies, embracing the general range of sciences, and sometimes even including literary subjects, exist at Aberdeen (founded in 1840), Birmingham (1858), Cambridge (1819), Edinburgh (1731), Glasgow (1802), Hull (1823), Leeds (1820), Manchester (1781), Newcastle (1793), and York (1822), while at Dublin, where individuality seems ever to flourish in various departments of civilised activity, there are two such societies with, apparently, partly overlapping interests in general science—the Royal Dublin Society, founded in 1731, and the Royal Irish Academy, founded in 1785.

There are not many among these societies the publications of which can be safely neglected by the research worker in any of the specialised branches of science, and yet most of them could not show an average annual output of one serious paper in each of the science subjects as defined by the twelve sections of the British Association. They become in turn the fortunate victims of some local enthusiast, who, in time, passes away like a comet or finds wider scope for his ambitions, either in the Royal Society of London or in the metropolitan society that governs his own pet subject, where his products enjoy the benefit of more thorough discussion, often with appreciation, by fellow-experts.

If we take the Literary and Philosophical Society of this city (which for many years has devoted itself almost entirely to science, and issues memoirs which

no serious worker can afford to overlook) we get an example of the way in which the student is taxed in his search for the "previous literature." Of ninety-one papers published in the Manchester Memoirs during the past five years as many as thirty-four belong to a class that would be referred to Section A of this association, this abundant enthusiasm being largely due to a local occurrence of radio-activity. Of the remainder ten would come under Section B, seven, entirely palæontological in character, come under Section C, twenty-two under D, two under H, two under I, thirteen under K, and one under M.

One can sympathise with those readers who grumble at the one halfpenny-worth of geological bread to this intolerable deal of physical and biological sack.

Now, it is important to remember that this society is maintained by fewer than 150 members, many of whom are members only through general interest in science or merely in consequence of a commendable desire to keep alive an institution which has an honourable record. The critical discussion of most papers presented must therefore be confined to a very small number, and herein arises a danger that may at any time give rise to consequences far more serious than the burial of a paper with an overburden of unrelated literature; for the author of the paper himself must often be the only member capable of deciding as to whether his paper is or is not suitable for record as a definite addition to scientific data or thought.

To the outside student, therefore, the publication of a paper by such a small society gives no *prima facie* reason for regarding it as a serious and probably trustworthy addition to scientific literature. The papers so issued must be most embarrassingly unequal and wholly indeterminate in character; yet no stranger can run the risk of disregarding such publications.

But the tax thus laid on students of scientific literature is not the only drawback or danger due to the activities of such small local non-specialised societies. They often possess collections of natural history specimens or of physical instruments for which they become, by mere possession, trustees to the whole scientific world. As in the case of published literature, the circumstance that these things are often unknown to the rest of the world or are almost inaccessible to the student is only one and not the most serious danger; for one knows instances of collections suffering from neglect, or, still worse, suffering from the activities of some member who temporarily dominates the governing body, and entertains strong views as to the cost of maintaining collections that, from his special point of view, are of no value.

Before proposing, in the name of organisation, to abolish such unspecialised societies, or before even suggesting that they might be allowed to die a natural death, one should exert one's ingenuity to devise some scheme for turning them to account. They inherit traditions in most cases that only an unregenerate iconoclast would despise; most of them were founded when science was barely specialised, and when facilities for attending London meetings were imperfect; many of them have published memoirs that are now of classical value, and have included among their active members the most worthy names in the history of science; most of them possess libraries that could not now be purchased for money, although these are often neglected, and, for financial reasons, often difficult to use.

Even as monuments, therefore, societies such as those that I have mentioned deserve preservation. How, then, can one turn their resources to good account and organise their culture without the drawbacks of *Kultur?*

The plan that has often occurred to me as a possible compromise between the claims of central organisation and provincial autonomy is this. The recognised chief among such societies—the Royal Society of London—should, by affiliation of its provincial poor relations, take over the cost as well as the responsibility of their serious publications. They would enjoy home rule so far as their meetings, discussions, finances, and libraries are concerned; but the papers offered for publication would be censored in the usual way by the appropriate sectional committees of the Royal Society, and, if passed, would be published, either in the Proceedings and Transactions of the Royal or of some metropolitan specialised society. Such papers would then rank technically, not by mere courtesy, as "publications" for purposes of quotation or priority. The local interest in science would not then be curtailed, and the geographical handicap, especially felt by junior provincial workers, would be removed, while the provincial scientific communities would be able to maintain their treasured monuments, without, as now, a constant fear of financial difficulties, and without a recurring dread that senility in the respected old "lit. and phil." will soon end in the way of all things living.

So far as our local example is concerned, many, if not most, of the papers which I have just classified by the B.A. system might well have been accepted by the Royal Society, for the majority of the papers published in its Proceedings are also by non-members. The last six volumes of the Proceedings of the Royal Society contain papers by 384 authors, of whom only 141 are fellows of the society.

I am quite aware of many difficulties in the way of this proposal—fears on the one side that the council of the Royal Society will acquire a dangerous power of controlling the freedom of the scientific writer, and forebodings on the other that the duties of the council threaten to become "heavy burdens and grievous to be borne," while the cost of such additional publications will be removed from the local body only to be thrust upon the Royal Society.

The circumstance that a young worker's paper has been hall-marked by the Royal Society will soon be regarded as fair compensation for what would, after all, be but partial loss of freedom; for the local societies, as well as the various journals, can still publish what they like, though the foreign student may not be blamed for neglecting any but technically published scientific literature.

The extra burdens added to the council and sectional committees of the Royal Society are merely of a kind that someone *must* undertake if we are to have any regard at all for the progress of science, and it will soon be necessary for the State to recognise the national value of the work done by the council and committees of the Royal Society in more ways than nominal recognition of their ornamental positions. In practically every country on the continent of Europe the premier learned academies that occupy positions corresponding to the Royal Society of London are financially supported by the State, and even the ordinary members are paid.

In this country scientific organisations, like the universities, are largely dependent on private charity, with the result that, while we get the benefits of individuality and local competition, we suffer, as the war has already proved to us, the necessary loss of power due to an undesirable number of wheels in our machine, due to unnecessary duplication of effort, and due to industrial and financial eddies in the stream of progress; in a word, due to want of method and organisation. That is the theme which I wish the delegates present to take back for practical consideration by the societies that we represent.

It is important to remember that organisation necessarily requires someone to take the lead and someone to fill the subordinate's place; otherwise, all is anarchy, and whatever may be the discipline within each society, their relations to one another at present can but be described as anarchy; the fellow of the Royal Society has no more responsibility at present than any member of the smallest debating club; his selection is regarded as an honour, but an honour is as meaningless as an iron cross if it does not imply responsibility and an opportunity for more work. What applies to an individual applies to a society of such persons. The premier position of the Royal Society is acknowledged by every British worker in science, and those societies which similarly embrace all phases of science can assist the aims of organisation by reminding the Royal Society that its position is more than ornamental, and that its lead will be welcomed.

SECTION I.

PHYSIOLOGY.

OPENING ADDRESS BY PROF. W. M. BAYLISS, M.A., D.SC., F.R.S., PRESIDENT OF THE SECTION.

The Physiological Importance of Phase Boundaries.

EVEN a hasty consideration of the arrangements present in living cells is sufficient to bring conviction that the physical and chemical systems concerned operate under conditions very different from those of reactions taking place between substances in true solution. We become aware of the fact that there are numerous constituents of the cell which do not mix with one another. In other words, the cell system is one of many "phases," to use the expression introduced by Willard Gibbs.

Further, parts of this system which appear homogeneous under the ordinary microscope are shown by the ultra-microscope to be themselves heterogeneous. These are in what is known as the colloidal state. Some dispute has taken place as to whether this state is properly to be called a heterogeneous one, but it is sufficient for our purpose to note that investigation shows that the interfaces of contact between the components of such systems are the seat of the various forms of energy which we meet with in the case of systems obviously consisting of phases which can be separated mechanically, so that considerations applying to coarsely heterogeneous systems apply also to colloidal systems. Although the phases of a colloidal system cannot be so obviously and easily separated as those of an ordinary heterogeneous one, this can be done almost completely by filtration through membranes such as the gelatin in Martin's process. To avoid confusion, however, it has been suggested that the colloidal state should be spoken of as "micro-heterogeneous." There are, in fact, certain phenomena more or less peculiar to the colloidal state and due to the influence of the sharp curvature of the surfaces of the minutely subdivided phase. The effect of this curvature is a considerable pressure in the interior of the phase, owing to the surface tension, and it adds further complexity to the properties manifested by it.

We see, then, that the chemical reactions of chief importance to us as physiologists are those known as "heterogeneous." This class of reactions, until comparatively recent times, has been somewhat neglected by the pure chemist.

In some of its aspects, the problem before us was discussed by one of my predecessors, Prof. Hopkins, as also by Prof. Macallum, but its importance will, I think, warrant my asking your indulgence for a further brief discussion. Permit me first to apologise for what may seem to some of those present to be an unnecessarily elementary treatment of certain points.

It is easy to realise that the molecules which are situated at the interface where two phases are in contact are subject to forces differing from those to which the molecules in the interior of either phase are subject. Consider one phase only, the molecules at its surface are exposed on the one side to the influence of similar molecules; on the other side, they are exposed to the influence of molecules of a nature chemically unlike their own or in a different physical state of aggregation. The result of such asymmetric forces is that the phase boundary is the seat of various forms of energy not present in the interior of the phase. The most obvious of these is the surface energy due to the state of tension existing where a liquid or a gas forms one of the phases. It would lead us too far to discuss the mode of origin of this surface tension, except to call to mind that it is due to the attractive force of the molecules for one another, a force which is left partially unbalanced at the surface, so that the molecules here are pulled inwards. The tension is, of course, only the intensity factor of the surface energy, the capacity factor being the area of the surface. We see at once that any influence which alters the area of the surface alters also the magnitude of that form of energy of which we are speaking.

This is not the only way in which the properties of substances are changed at phase boundaries. The compressibility of a solvent, such as water, are altered, so that the solubilities of various substances in it are not the same as in the interior of the liquid phase. It is stated by J. J. Thomson that potassium sulphate is 60 per cent. more soluble in the surface film. The ways in which the properties of a solvent are changed are sometimes spoken of as "lyotropic," and they play an important part in the behaviour of colloids. We meet also with the presence of electrical charges, of positive or negative sign. These are due, as a rule, to electrolytic dissociation of the surface of one phase, in which the one ion, owing to its insolubility, remains fixed at the surface, while the opposite ion, although soluble, cannot wander away further than permitted by electrostatic attraction. Thus we have a Helmholtz double layer produced.

Before we pass on to consider how these phenomena intervene in physiological processes, there is one fact that should be referred to on account of its significance in connection with the contractile force of muscle. Surface tension is found to *decrease* as the temperature rises, or, as it is sometimes put, it has a negative temperature coefficient. This is unusual; but, if we remember that the interface between a liquid and its vapour disappears when the temperature rises to the critical point, and with it, of course, all phenomena at the boundary surface, the fact is not surprising that there is a diminution of these phenomena as the critical temperature is approached.

Perhaps that result of surface energy known as "adsorption" is the one in which the conditions present at phase boundaries make themselves most frequently obvious. Since the name has been used somewhat loosely, it is a matter of some consequence to have clear ideas of what is meant when it is made use of. Unless it is used to describe a definite fact, it can only be mischievous to the progress of science.

Permit me, then, first to remind you of that fact of universal experience, known as the "dissipation of energy," which is involved in the second law of energetics. Free energy—that is, energy which can be used for the performance of useful work—is in-

variably found to diminish, if the conditions are such that this is possible. If we have, therefore, a system in which, by any change of distribution of the constituents, free energy can be decreased, such a change of distribution will take place. This is one form of the well-known "Principle of Carnot and Clausius."

Now, practically any substance dissolved in water lowers the surface tension present at the interface between the liquid and another solid or liquid phase with which it is in contact. Moreover, up to a certain limit, the magnitude of this effect is in proportion to the concentration of the solute. Therefore, as was first pointed out by Willard Gibbs, concentration of a solute at an interface has the effect of reducing free energy and will therefore occur. This is adsorption. As an example, we may take the deposition of a dye-stuff on the surface of charcoal, from which it can be removed again, unaltered, by appropriate means, such as extraction with alcohol. Charcoal plus dye may, if any satisfaction is derived from the statement, be called a compound. But, since its chemical composition depends on the concentration of the solution in which it was formed, it is much more accurate to qualify the statement by calling it an "adsorption-compound." Moreover, the suggestion that the union is a chemical one tends to deprive the conception of chemical combination of its characteristic quality, namely, the change of properties. Dye-stuff and charcoal are chemically unchanged by adsorption.

The origin of adsorption from surface tension is easily able to explain why it is less as the temperature rises, as we find experimentally. As we have just seen, surface tension diminishes with increase of temperature.

Let us next consider what will happen if the liquid phase contains in solution a substance which lowers surface tension and is also capable of entering into chemical reaction with the material of which the other, solid, phase consists. For example, a solution of caproic acid in contact with particles of aluminium hydroxide. On the surface of the solid, the concentration of the acid will be increased by adsorption, and, in consequence, the rate of the reaction with it will be raised, according to the law of mass action. Further, suppose that the liquid phase contains two substances which react slowly with each other, but not with the solid phase. They will be brought into intimate contact with each other on the surface of the solid phase, their concentration raised and the rate of their interaction increased. One of the reagents may clearly be the solvent itself. But in all these cases the rate of the reaction cannot be expressed by a simple application of the law of mass action, since the active masses are not functions of the molecular concentrations, but of the surface of the phase boundaries. The application of these considerations to the problem of the action of enzymes and of heterogeneous catalysis in general will be apparent. That the action of enzymes is exerted by their surfaces is shown, apart from the fact that they are in colloidal solution, by the results of experiments made in liquids in which the enzymes themselves are insoluble in the usual sense, so that they can be filtered off by ordinary filter paper and the filtrate found to be free from enzyme. Notwithstanding this insolubility, enzymes are still active in these liquids. The statement has been found, up to the present, to apply to lipase, emulsin, and urease, probably to trypsin, and the only difficulty in extending it to all enzymes is that of finding a substrate soluble in some liquid in which the enzyme itself is not. That adsorption is a controlling factor in the velocity of enzyme action has been advocated by myself for some years, but it is not to be understood as implying that the whole action of enzymes is an "adsorption phenomenon," whatever may be the meaning of this statement. The rate at which the chemical reaction proceeds is controlled by the mass of the reagents concentrated on the surface of the enzyme phase at any given moment, but the temperature coefficient will, of course, be that of a chemical reaction.

The thought naturally suggests itself, may not the adsorption of the reacting substances on the surface of the enzyme suffice in itself to bring about the equilibrium at a greater rate, so that the assumption of a secondary chemical combination of a chemical nature between enzyme and substrate may be superfluous? I should hesitate somewhat to propose this hypothesis for serious consideration were it not that it was given by Faraday as the explanation of one of the most familiar cases of heterogeneous catalysis, namely, the union of oxygen and hydrogen gases by means of the surfaces of platinum and other substances. The insight shown by Faraday into the nature of the phenomena with which he was concerned is well known and has often caused astonishment. Now, this case of oxygen and hydrogen gases is clearly one of those called "catalytic" by Berzelius. The fact that the agent responsible for the effect did not itself suffer change was clear to Faraday. I would also, in parenthesis, direct attention to the fact that he correctly recognised the gold solutions which he prepared as suspensions of metallic particles—that is, as what we now call colloidal solutions. Although the systematic investigation of colloids, and the name itself, were due to Graham, some of the credit of the discovery should be given to the man who first saw what was their nature. Adsorption, again, was accurately described by Faraday, but without giving it a name.

I confess that there are, at present, difficulties in the way of accepting concentration by adsorption as a complete explanation of the catalytic activities of enzymes. It is not obvious, for example, why the same enzyme should not be able to hydrolyse both maltose and saccharose, as it is usually expressed. Another difficulty is that it is necessary to assume that the relative concentration of the components of the chemical system must be the same on the surface of the enzyme as it is in the body of the solution; in other words, the adsorption of each must be the same function of its concentration. Unless this were so, the equilibrium position on the enzyme surfaces, and therefore in the body of the solution, would be a different one under the action of an enzyme from that arrived at spontaneously or brought about by a homogeneous catalyst such as acid. This consideration was brought to my notice by Prof. Hopkins, and requires experimental investigation. We know, indeed, that in some cases there is such a difference in the position of the equilibrium position, for which various explanations have been suggested. But it would be a matter of some interest to know whether this difference has any relation to different degrees of adsorption of the components of the system.

At the same time, adsorption is under the control of so many factors, surface tension, electrical charge, and so on, that the possibilities seem innumerable. There are, moreover, two considerations to which I may be allowed to direct your attention. Hardy has pointed out that it is probable that the increased rate of reaction at the interface between phases may be due, not merely to increased concentration as such, but that in the act of concentration itself molecular forces may be brought into play which result in a rise in chemical potential of the reacting substances. In the second place, Barger has shown that the adsorption of iodine by certain organic compounds is clearly related to the chemical composition of the surfaces of these substances, but that this relationship does not result in

chemical combination or in abolition of the essential nature of the process as an adsorption. It would appear that those properties of the surface, such as electric charge and so on, which control the degree of adsorption, are dependent on the chemical nature of the surface. This dependence need not cause us any surprise, since the physical properties of a substance, inclusive of surface tension, are so closely related to its chemical composition.

There is one practical conclusion to be derived from the facts already known with regard to enzymes. This is, that any simple application of the law of mass action cannot lead to a correct mathematical expression for the rate of reaction, although attempts of this kind have been made, as by Van Slyke. The rate must be proportional to the amount of substrate adsorbed, and this, again, is a function both of the concentration of the substrate and of that of the products. It is, then, a continuously varying quantity. Expressed mathematically, the differential equation for the velocity must be something of this kind:—

$$\frac{dC}{dt} = KC^n$$

where n itself is an unknown function of C, the concentration of the substrate or products.

The hypothesis of control by adsorption gives a simple explanation of the exponential ratio between the concentration of the enzyme and its activity, which is found to be different numerically according to the stage of the reaction. At the beginning, it may be nearly unity; in the middle it is more nearly 0·5, as in the so-called 'square root law' of Schütz and Borissov, which is, however, merely an approximation. Simple explanations are also given of the fact that increasing the concentration of the substrate above a certain value no longer causes an increased rate of reaction. This is clearly because the active surface is saturated. Again, the effect of antiseptics and other substances which, by their great surface activity, obtain possession of the enzyme surfaces, and thereby exclude to a greater or less degree the adsorption of the substrate, receives a reasonable account. In many cases, the depressant or favouring action of electrolytes, including acid and alkali, is probably due to aggregation or dispersion of the colloidal particles of the enzyme, with decrease or increase of their total surface. It is to be noted that such explanations are independent of any possible formation of an intermediate compound between enzyme and substrate, *after* adsorption has taken place.

There is a further way in which adsorption plays a part in the chemical processes of cells, including those under the influence of catalysts. It is a familiar fact that the concentration of water plays a large part in the position of equilibrium attained in reversible reactions of hydrolysis and synthesis. A synthetic process is brought about by diminution of the effective concentration of water. There are, doubtless, means of doing this in the elaborate mechanisms of cell life, and, in all probability, it is by adsorption on surfaces, which are able to change their "affinity" for water.

I pass on to consider briefly some other cases in which the phenomena at phase boundaries require attention.

Let us turn our gaze from the interior of the cell to the outer surface, at which it is in contact with the surrounding medium. From the nature of adsorption there can be no doubt that, if the cell or the surrounding liquid contains substances which decrease surface energy of any form, these constituents will be concentrated at the interface. There are many such substances to be found in cells, some of lipoid nature, some proteins, and so on. Further, the experiments of Ramsden have shown that a large number of substances are deposited in surface films in a more or less rigid or solidified form. We are thus led to inquire whether these phenomena do not account for the existence of the cell membrane, about which so much discussion has taken place. We find experimentally that there are facts which show that this membrane, under ordinary resting conditions, is impermeable to most crystalloids, including inorganic salts, acids, and bases. There is no other explanation of the fact that the salts present in cells are not only in different concentration inside from that outside, but that there may be absence of certain salts from one which are present in the other, as, for example, sodium in the plasma of the rabbit not in the corpuscles. Moreover, the experiments of Hoeber have shown that electrolytes are free in the cells, so that they are not prevented from diffusion by being fixed in any way. The mere assumption of a membrane impermeable to colloids only will not account for the facts, since, as I have shown in another place, this would only explain differences of concentration, but not of composition. The surface concentration of cell constituents readily accounts for the changes of permeability occurring in functional activity, since it depends on the nature of the cell protoplasm, and chemical changes of many and various kinds occur in this system. If such be the nature of the cell membrane, it is evident that we are not justified in expecting to find it composed of lipoid or of protein alone. It must have a very complex composition, varying with the physiological state of the cell. Indeed, complex artificial membranes have been prepared having properties very similar to that of the cell.

This view that the membrane is formed by surface condensation of constituents of the cell readily accounts for the changes of permeability occurring in functional activity, since its composition depends on that of the cell protoplasm, and chemical changes of various kinds take place in this system, as it is scarcely necessary to remind you. In fact, the cell membrane is not to be regarded as an independent entity, but as a working partner, as it were, in the business of the life of the cell. In the state of excitation, for example, there is satisfactory evidence that the cell membrane loses its character of semi-permeability to electrolytes, etc. This statement has been shown to apply to muscle, nerve, gland cells, and the excitable tissues of plants, as well as to unicellular organisms. We shall see presently how this fact gives a simple explanation of the electrical changes associated with the state of activity.

If, then, the cell membrane is a part of the cell system as a whole, it is not surprising to find that substances can affect profoundly, although reversibly, the activities of the cell, even when they are unable to pass beyond the outer surface. The state of dynamic equilibrium between the cell membrane and the rest of the cell system is naturally affected by such means, since the changes in the one component involve compensating ones in the other. Interesting examples of such actions are numerous. I may mention the effect of calcium ions on the heart muscle, the effect of sodium hydroxide on oxidation in the eggs of the sea-urchin, and that of acids on the contraction of the jelly-fish. Somewhat puzzling are those cases in which drugs, such as pilocarpine and muscarine, act only during their passage through the membrane and lose their effect when their concentration has become equal inside and outside the cell.

The work of Dale on anaphylaxis leads him to the conclusion that the phenomena shown by sensitised plain muscle can most reasonably be explained by colloidal interaction on the surface of the fibres. The

result of this is increased permeability and excitation resulting therefrom.

I referred previously to the electrical change in excitable tissues and its relation to the cell membrane. It was, I believe, first pointed out by Ostwald and confirmed by many subsequent investigators, that in order that a membrane may be impermeable to a salt it is not a necessary condition that it shall be impermeable to both the ions into which this salt is electrolytically dissociated. If impermeable to one only of these ions, the other, diffusible, ion cannot pass out beyond the point at which the osmotic pressure due to its kinetic energy balances the electrostatic attraction of the oppositely charged ion, which is imprisoned. There is a Helmholtz double layer formed at the membrane, the outside having a charge of the sign of the diffusible ions, the inside that of the other ions. Now, suppose that we lead off from two places on the surface of a cell having a membrane with such properties to some instrument capable of detecting differences of electrical potential. It will be clear that we shall obtain no indication of the presence of the electrical charge, because the two points are equipotential, and we cannot get at the interior of the cell without destroying its structure. But if excitation means increased permeability, the double layer will disappear at an excited spot owing to indiscriminate mixing of both kinds of ions, and we are then practically leading off from the interior of the cell, that is, from the internal component of the double layer, while the unexcited spot is still led off from the outer component. The two contacts are no longer equipotential. Since we find experimentally that a point at rest is electrically positive to an excited one, the outer component must be positive, or the membrane is permeable to certain cations, impermeable to the corresponding anions. Any action on the cell such as would make the membrane permeable, injury, certain chemical agents, and so on, would have the same effect as the state of excitation. If we may assume the possibility of degrees of permeability, the state of inhibition might be produced by *decrease* of permeability of the membrane of a cell, which was previously in a state of excitation owing to some influence inherent in the cell itself or coming from the outside. This manner of accounting for the electromotive changes in cells is practically the same as that given by Bernstein.

It will be found of interest to apply to secretory cells the facts to which I have directed your attention. If we suppose that the setting into play of such cells is associated with the production of some osmotically active substance, together with abolition of the state of semi-permeability of the membrane covering the ends of the cells in relation with the lumen of the alveolus of the gland, it is plain that water would be taken up from the lymph spaces and capillaries and escape to the duct, carrying with it the secretory products of the cells. This process would be continuous so long as osmotically active substances were formed. Such a process has been shown by Lepeshkin to occur in plants, and we have also evidence of increased permeability during secretory activity in the gland cells of animals. From what has been said previously, it is evident that electrical differences would show themselves between the permeable and semi-permeable ends of such cells, as has been found to be the case.

As a modifiable structure, we see the importance of such a membrane as that described if it takes part in the formation of the synapse between neurones. The manifold possibilities of allowing passage to states of excitation or inhibition and of being affected by drugs will be obvious without further elaboration on my part.

Enough has already been said, I think, to show the innumerable ways in which phenomena at phase boundaries intervene in physiological events. Indeed, there are very few of these, if any, in which some component or other is not controlled by the action of surfaces of contact. But there is one especially important case to which I may be allowed to devote a few words in conclusion. I refer to the contractile process of muscle. It has become clear, chiefly through the work of Fletcher, Hopkins, and A. V. Hill, that what is usually called muscular contraction consists of two parts. Starting from the resting muscle, we find that it must have a store of potential energy, since we can make it do work when stimulated. After being used in this way, the store must be replenished, since energy cannot be obtained from nothing. This restoration process is effected by an independent oxidation reaction, in which carbohydrate is burnt up with the setting free of energy which is made use of to restore the muscle to its original state. Confining our attention for the moment to the initial, contractile, stage, the essential fact is the production of a certain amount of energy of tension, which can either be used for the performance of external work or be allowed to become degraded to heat in the muscle itself. It was Blix who first propounded the view that the amount of this energy of tension is related to the magnitude of certain surfaces in the muscle fibres. But the fact was demonstrated in a systematic and quantitative manner by A. V. Hill. He showed, in fact, that the amount of energy set free in the contractile process is directly related to the length of muscle fibres during the development of the state of tension. In other words, the process is a surface phenomenon, not one of volume, and is directly proportional to the area of certain surfaces arranged longitudinally in the muscle. This same relationship has been shown by Patterson and Starling to hold for the ventricular contraction of the mammalian heart and by Kosawa for that of the cold-blooded vertebrate. It appears that all the phenomena connected with the output of blood by the heart can be satisfactorily explained by the hypothesis that the energy of the contraction is regulated by the *length* of the ventricular fibres during the period of development of the contractile stress. The degree of filling at the moment of contraction is thus the determining factor.

That surface tension itself may be responsible for the energy given off in muscular contraction was first suggested by Fitzgerald in 1878, and it seems, from calculations made, that changes at the contact surface of the fibrillæ with the sarcoplasm may be capable of affording a sufficient amount. The difficulties in deciding the question are great, but, in addition to the facts mentioned, there is other interesting evidence at hand. It has been shown, by Gad and Heymans, by Bernstein and others, that the contractile stress produced by a stimulus has a negative temperature coefficient. Within the limits of temperature between which the muscle can be regarded as normal, this stress is the greater the lower the temperature. The same statement was shown by Weizsäcker (working with A. V. Hill) to hold for the heat developed in the contractile stage. Now, of all the forms of energy possibly concerned, that associated with phase boundaries is the only one with a negative temperature coefficient. Another aspect of this relation to temperature is the well-known increase of the tonus of smooth muscle with fall in temperature.

It is tempting to bring into relation with the change in surface tension the production of lactic acid. In fact, this idea was put into a definite statement by Haber and Klemensievich in 1909 in a frequently quoted paper on the forces present at phase boundaries.

The production of acid is stated to alter the electrical forces at this situation. This electrical charge involves a change of surface tension, and it is this change of surface tension which brings about the mechanical deformation of the muscle. Mines also has brought forward good evidence that the production of lactic acid is responsible for the change of tension. As to how the lactic acid is set free, and of what nature the system of high potential present in muscle may be, we require much more information. The absence of evolution of carbon dioxide when oxygen is not present shows that no oxidation takes place in the development of tension. There are other difficulties also in supposing that this system present in resting muscle is of a chemical nature. If the energy afforded by the oxidation of carbohydrate in the recovery stage is utilised for the formation of another chemical system with high energy content, the theory of coupled reactions indicates that there must be some component common to both systems. It is difficult to see what component of the muscle system could satisfy the conditions required. On the whole, some kind of system of a more physical nature seems the most probable. If it be correct that the oxidation of substances other than carbohydrate, fat, for example, can afford the chemical energy for muscular contraction, as appears from the results of metabolism experiments, a further difficulty arises in respect to a coupled reaction. But the question still awaits investigation.

On the whole, I think that we may conclude that more study of the phenomena at phase boundaries will throw light on many problems still obscure. It would probably not be going too far to say that the peculiarities of the phenomena called "vital" are due to the fact that they are manifestations of interchange of energy between the phases of heterogeneous systems. It was Clerk Maxwell who compared the transactions of the material universe to mercantile operations in which so much credit is transferred from one place to another, energy being the representative of credit. There are many indications that it is just in this process of change of energy from one form to another that special degrees of activity are to be observed. Such, for example, are the electrical phenomena seen in the oxidation of phosphorus or benzaldehyde, and it appears that, in the photo-chemical system of the green plant, radiant energy is caught on the way, as it were, to its degradation to heat, and utilised for chemical work. In a somewhat similar way, it might be said that money in the process of transfer is more readily diverted, although perhaps not always to such good purpose as in the chloroplast. Again, just as in commerce money that is unemployed is of no value, so it is in physiology. Life is incessant change or transfer of energy, and a system in statical equilibrium is dead.

SECTION L.

EDUCATIONAL SCIENCE.

OPENING ADDRESS BY MRS. HENRY SIDGWICK, PRESIDENT OF THE SECTION.

WHEN I look at the names of many of my predecessors in this presidential chair, when I read their addresses, or when I consider what the work of the Section ought to be, I feel that an apology is needed for my being here at all.

Let me say at once, however, that it is not because of my being a woman that I feel this. It is true that I am the first woman who has had the honour of presiding over Section L. But it is obviously very fitting that a woman should sometimes do so; and this not only because women are as much concerned with the results of educational science as men are—that might be said about all departments of science; nor only because the material on which education works—the human material to be educated—is approximately evenly divided between the sexes. A more important consideration is that women have the largest share in the work of education. This is clear if we take education in its widest and fullest sense, and include in it what is done in the home as well as in the school, beginning as it must with the earliest infancy. But it is also true if we limit the meaning of the word education—in the way that is constantly done, and is I think usually done in the discussions that take place in this Section—to that part of it with which the professional educator, the school or college teacher, is concerned. For the fact that the school teaching, not only of girls, but of the younger children of both sexes, is mainly in the hands of women, results of necessity in there being a larger number of professional teachers among women than among men.

May it not be added that in some departments of education women have appeared to take their profession more seriously than men so far as this can be measured by the trouble taken in training for it? For I think I am right in saying that among persons proposing to teach in secondary schools more women in proportion than men have hitherto availed themselves of opportunities for professional training.

From another point of view, too, the education of women and girls has an interest which, though not different in kind, is greater in degree than that of the other sex. I mean in the rapidity of its growth and development since the middle of the last century. The development of school and university education and of technical education has, of course, been very great for both sexes. Much attention has been devoted to improving its quality, and perhaps even more to increasing its quantity, by making it more accessible to all classes of people. But in the case of girls and women the progress has been greater and more remarkable than in that of boys, for it started from a lower level, and notwithstanding this it would, I think, be difficult to point out in what respects the educational opportunities of women are now inferior to those of men. I say this, of course, in a general sense, and without prejudice as to controversial questions of detail such as the merits of the methods and curricula deliberately adopted for different schools.

The Report of the Schools Inquiry Commission published in 1868, in what it says about girls' education at that time, gives us a standard of comparison and a means of estimating the progress made. It has often been quoted, but may bear quoting again. The Commissioners say:[1]

"The general deficiency in girls' education is stated with the utmost confidence, and with entire agreement, with whatever difference of words, by many witnesses of authority. Want of thoroughness and foundation; want of system; slovenliness and showy superficiality; inattention to rudiments; undue time given to accomplishments, and those not taught intelligently or in any scientific manner; want of organisation—these may sufficiently indicate the character of the complaints we have received, in their most general aspect. It is needless to observe that the same complaints apply to a great extent to boys' education. But on the whole the evidence is clear that, not as they might be, but as they are, the girls' schools are inferior in this view to the boys' schools."

This was what could be said of schools in 1868, and is certainly in striking contrast to what could be said now. And if we turn from the schools to higher education we find this was practically non-existent for women at that time. Its absence was indeed one

[1] Report of the Schools Inquiry Commission, p. 548.

cause of the badness of the schools. The schools were bad because the teachers were inadequately educated. "The two capital defects of the teachers of girls," as one of the Assistant Commissioners (Mr. Bryce, now Lord Bryce) reported, "are these: they have not themselves been taught and they do not know how to teach." These defects were, of course, partly due to the badness of the schools, and the want of any standard enabling the general public and the teachers themselves to judge of their badness. So far it was a vicious circle. The teachers were badly taught in bad schools and handed on the bad results to the schools they later taught in. But the defects were partly due to the absence of opportunity for them to carry their own education beyond that of their elder pupils—to obtain that higher education which men obtained at the universities. This was pointed out by the Commissioners, and their report acted as a great help and encouragement to those who had already realised the need of higher education for women, and gave an important stimulus to the foundation of colleges for women, first at Cambridge and then at Oxford.

The Commissioners' report also greatly encouraged the movement already in progress for the improvement of girls' schools—the movement in which Miss Buss, of the North London Collegiate School, and Miss Beale, of the Cheltenham Ladies' College, were among the pioneers, and in which the opening of local examinations to girls in 1865 by Cambridge was an important step. The cautious and anxious way in which the Commissioners refer to the possible effects on girls of more exacting school work and of examinations is amusing to read now. But the report of the Commission helped in the progress of girls' education in still another way, for it was instrumental in securing the recovery for the secondary education of girls of endowments which had been allowed to lapse into the service of primary education or to be absorbed by boys; and the division between girls and boys of some endowments not specifically assigned to either sex by the founders. Twenty years ago—in 1895—the Charity Commissioners in their annual report gave striking testimony to what has been done both in this way and by new endowments:—

"There is reason to think," they said, "that the latter half of the nineteenth century will stand second in respect of the greatness and variety of the charities created within its duration to no other half-century since the Reformation. And, as to one particular branch of educational endowment, namely, that for the advancement of secondary and superior education of girls and women, it may be anticipated that future generations will look back to the period immediately following upon the Schools Inquiry Commission and the consequent passing of the Endowed Schools Acts, as marking an epoch in the creation and application of endowments for that branch of education similar to that which is marked, for the education of boys and men, by the Reformation."

And the flow of endowments for this branch of education has not ceased since the report just quoted from was written. As examples of it I may remind you of the St. Paul's Girls' School, the extension and rebuilding of Bedford College, University of London, and the large sums given for the domestic department of King's College for Women.

Though, however, as the Charity Commissioners say, a great impulse was given to girls' education by the report of the Schools Inquiry Commission and the legislation as regards endowments that followed, I think that, even without these, great progress would have been made, though probably less rapidly. The desire for it was already there. Women who had themselves suffered from the previous deficiency were working for improvement, and sympathetic men friends were helping. It was becoming more and more obvious not only that women teachers must have adequate opportunities of learning, but that the home no longer in itself afforded sufficient scope for the energies of the daughters, especially unmarried daughters, of the professional classes, and that they must be trained for other useful work. The supply of suitable education followed the demand, as generally happens when the demand is strong and clear. The very mention by the Charity Commissioners in the passage I have quoted of the *creation* as well as of the *application* of endowments for the purposes of female education is evidence of the active public interest in the matter. The spirit which has led during the last half-century to the liberal endowment of education for girls and women from private sources has also led the State, and public bodies generally, to consider girls equally with boys in all public administration of education or of educational funds. The same spirit has led the newer universities without exception to admit women to their benefits on equal terms with men. And at the same time the creation of some professions and skilled industries—*e.g.* sick nursing—by women, and the opening to them of others, together with the general movement in favour of professional training for professional work, have led to the great development of opportunities of technical or vocational training for women as well as for men.

This immense—almost revolutionary—change, as regards educational opportunities for women, which has occurred within the recollection of people of my age, and which must be attributed largely to the efforts of women themselves, is, I think, very striking; and it certainly, as I said, fully justifies the selection of a woman to preside over the Educational Section of the British Association. The apology I feel to be needed is for the particular woman selected. For it is the science of education, or at any rate the science and art of education, that this Section presumably exists to advance, and I am no educator, no teacher; I have made no psychological study of young people from an educational point of view, nor of the different methods of teaching suited to different ages, no statistical investigation of the influence or particular curricula in training the mind or furnishing it with useful information. I have, in short, neither made contributions to the science of education nor practised the art. Any work I have done has been on the administrative side, and I can speak only as a member of the general public—not as an expert. And what is there new, in a subject so much discussed, for a member of the general public to say? An illuminating address is, I fear, in the circumstances impossible.

Not that I regard the view of the general public as unimportant. Indeed, I am not sure that a good case could not be made out for having a mere member of the general public as such as president from time to time. The general public must, as all will admit, decide what is to be spent on education, or, more strictly, on schools and colleges and professional educators, out of both public and private income—it is for them to decide on its relation to other social and family needs. But the concern of the public with education is not merely financial and administrative. It is more intimate than that. For education is not a subject like physics or chemistry on which only an expert has a right to an independent view. There are, no doubt, aspects of it of which only the expert can properly judge, there are experiments in it which only the expert can advantageously try, and there are, of course, departments of it in which the opinion of the expert is indispensable. But without depreciating either the science or art of education, it is clear that

when we take education in its widest sense it concerns everybody, and almost everybody is bound to have views about it. Each generation as a whole is responsible for handing on to the next the control over matter and mind, and the power of co-operation, which it has itself inherited from its forbears and added to, and which it must put its successors in a position to add to further. It is on this that the progress of the human race depends; without it each generation would have to start afresh from the beginning, and we should still be in the position of primitive man.

But the larger and more important part of education in this wide sense is done first in the nursery, and then, as the child gets beyond babyhood, by means of its own observation and imitation of its elders; while much is done by experience gained in mixing with others of its own age, and much by the exercise of responsibility. The education thus obtained, combined with precepts and with tales handed down orally, sufficed for our ancestors until the increasing complexity of life made it important for the rising generation to acquire skill and knowledge which mere imitation and experience could not give. When this happened division of labour took place in this as in other departments of life, and led to the introduction of the professional educator—that is, the educational expert who has the art of imparting the needed knowledge and skill, or at least of shortening the process of acquiring them. We may observe that his services are now required by all, and not, as was once the case, only by those preparing for the learned professions. This work of the professional educator is what our Section of the British Association is mainly concerned with, and the methods to be employed are best judged by the professional educators themselves. But the co-ordination of their work with the whole process of education, its place in the production of good citizens, must, as I have said, be judged, not by the professional educators alone, but by the whole body of the nation. The general public must not only be regarded as capable of exercising judgment on educational matters, but should be encouraged to feel that it is its duty to do so.

If we judge by the amount of talk which goes on about education, it would perhaps seem that the public is fully aware of its responsibilities. And yet I think there are indications that in some respects it fails to grasp them, and is disposed to depend too much on the professional educator; allowing itself to be confused by our habit of using the same word "education" in both the wider sense, of which we have been speaking, and also in the narrower sense of book-learning. The sense of proportion seems to me to be sometimes seriously lost from this cause.

I was impressed with an example of this exhibited a little while ago in a correspondence in the *Times* about the employment of the older boys in the elementary schools of country districts to do some of the work on the farms in place of farm-hands who have enlisted. One group of the correspondents, looking at the question from the point of view of agriculture, thought the advantage derived by the boy from his last year of school training was of small value to the country compared with the work he could do on the farm. The other group, looking at the question from the point of view of the school, thought it monstrous that what they called the "education" of the boy should be in any way curtailed. I am not at the moment concerned with the controversy itself, nor am I taking the side of either group of disputants. There is, of course, much to be said on both sides, and the decision should probably vary with the locality, and the work, and the farmer, and the boy. But what struck me was that all the disputants seemed to regard education as beginning and ending at school. None appeared to think of it in its wider sense. None referred to the great effect it might have on the boy's future life and character to feel that in a grave national crisis he had "done his bit"—an effect which would perhaps be all the greater if he felt he was sacrificing something to make up for which special effort might be needed later. I have seen the view of the gain to boys and girls from helping in the emergency put forward since, but not in the particular newspaper controversy in question, nor, I think, in connection with the loss of a year of schooling.

And there was another aspect of the question which did not seem to excite attention. I mean the possibly bad educational effect, in the wide sense, of preventing the boy from doing the work. To keep him at school, if he was conscious that his services were needed elsewhere, could not but tend to concentrate his attention on himself and the importance of his own schooling, and could not but tend to produce to some extent the deplorable temper of mind which leads some young people, a little older than the schoolboys over whom the controversy raged, to regard self-development as the aim and object of existence. This is certainly not the attitude of a good citizen—and to produce good citizens should, as we probably all agree, be the principal aim of education.

The particular difficulty to which I have referred seems inseparable from compulsory education, and probably cannot be altogether got over. The thoughtful girl of twelve, not absorbed in herself, must sometimes wonder whether her school-work is really as valuable as the help she could give her mother in some special difficulty or strain, except on the assumption that her own development ranks above all other objects.

Of course, the higher the relative value we put on scholastic education the less important will the loss of other educational influences appear to us. And perhaps at this point I had better frankly confess—what is, I fear, another defect in my qualifications as president of the Educational Section—namely, that I am not an enthusiast about education in the same sense that most of my hearers probably are. I read the other day in a review of the life of an American educationist that—

"He was penetrated with two characteristics which are the saving clause of the American and every other democracy, a reverence for learning and a flaming belief in education as the condition of success in any scheme of popular self-government."

In the reverence for learning I am with him, but I could not describe my belief in education—education, that is, in the sense here meant, namely, school and college education—as "flaming." I cannot, for instance, believe, as some seem to do, that by keeping children a year longer at school we should regenerate mankind, or at least secure as a matter of course great improvement. Why, you may ask, if I am not an enthusiastic believer in education, have I spent so much of my life—my time, my energy, my means —in helping to provide opportunities of university education for women? The answer is that I do believe very much in giving to as many people as possible educational opportunities—meaning by that in the first place the means of preparing for their work in life. Those who are going to teach, for instance, must obviously learn first, and, as I have just reminded you, women's opportunity of doing this was lamentably deficient half a century ago.

But secondly—and this is not at all less important—I mean by educational opportunity the means of satisfying intellectual curiosity, every spark of which should be fostered. For it is to intellectual curiosity that progress in knowledge, including physical science,

is mainly due. And intellectual curiosity is an important adjunct to the mental processes involved in understanding the world we live in, a valuable aid in the formation of a good judgment, and a great assistance in practical life. Intellectual curiosity and æsthetic sensibility are, moreover, the mainsprings of culture—that is, of some of the highest pleasures we can enjoy.

You will doubtless agree with this, and will agree, further, that without intellectual curiosity no amount of accumulated information can be properly assimilated, or will produce either culture or knowledge of permanent value. In its absence the pupil may pass through school and college with little advantage apart from discipline, beyond the acquisition of elementary skill in reading, writing, and arithmetic, and if he has a good memory a barren knowledge of some facts. You will probably add that it is one of the most important functions of the teacher to endeavour to produce this intellectual curiosity when absent or in abeyance, and that the zeal of the professional educator in this direction is a strong reason for enthusiastic belief in school education. It would be, I grant, if we could hope that the teacher's success would always be equal to his zeal; but notoriously this is far from being the case, and the failure is by no means always due to want of intelligence in the pupil any more than it is due to want of capacity in the teacher. In many cases, in all classes of society, the spark of intellectual curiosity—the response in the pupil's mind to educational stimulus—cannot be fanned into flame through book-learning alone, and yet may be there all the time ready to burst forth when it comes into contact with the needs of actual life and work. It may even be there, and fail to respond to imposed lessons, while it would blaze up if the pupil could by any means be induced to desire to learn before he is taught. It is partly because it is so important, if and when the desire to learn comes, that the boy or girl, man or woman, should be armed with the instruments which may give them independent means of acquiring the knowledge they desire, so far as this can be acquired through books, that we compel parents to send their children to school. No doubt, however, an even more important reason is our now almost universal use of reading and writing as a means of communicating with each other. The more widespread these arts are, the harder it is for anyone who has not acquired them to keep abreast of his fellows. But even now it would, of course, not be impossible, and the use of such phrases as compulsory education, in which education merely means the reverse of illiteracy, tends, I think, in itself to obscure the apprehension of what education really is, and to reduce the general sense of responsibility for it, and particularly that of parents.

Many years ago, before the days of compulsory education, or at least before it had time to produce any effect, I knew a man in the south of England who had had no school education, or practically none. I believe he could read a little with effort, but he could neither write nor keep accounts, so I was told. His wife did these things for him when they were necessary. He was, however, a good farmer, farmed a considerable amount of land, and acted as manager or agent under the landlord for a large estate. He knew his business thoroughly, had the power of managing men, and was much respected. It is impossible not to regard such a man as a more valuable member of the community, and a better-educated man in some respects, than many of those who climb the educational ladder to become clerks in an office. But, of course, such a man must have regretted that he had not had opportunities of schooling in his early youth—that he had not acquired the art of writing while he still had leisure. The want of the three R's must have been a serious handicap, only overcome by unusual ability. And, in fact, no one now doubts that it is almost as important to acquire these elementary arts as to learn to speak or walk. It is with the question of carrying school education further that doubt arises whether it is really the best education for everybody, and whether we ought to regard the person whose scholastic education has been longest, or who has succeeded best in examinations, as therefore necessarily the best educated.

I do not mean in saying this to set the practical man above the man of learning. Of course we want both, and we should like our schools to help to develop both. The value to the world of good scientific and literary work is enormous. And so far as science is concerned the British Association exists to bring home to the general public its value and interest, and consequently the importance of men who can advance it. Nor do I mean in what I have said to suggest any divorce between practice and learning. The business of most of us is practical, but what is to be desired is that everyone capable of it should combine practical ability—whether in manual work, or in organisation or administration, or in any other line—with a desire to learn; and that not only in relation to his work in life, but in a wider sphere. And, of course, we must wish that the means to satisfy this desire should be within everyone's reach. My point, therefore, is not that learning is not valuable, but that it is of little value unless it meets a desire in the learner's mind. And here the parents come in. The required attitude of mind is much more likely to be inspired by parents who possess it, than it is by the school. Or let us say that those children are most likely to grow up with it whose parents combine with the school to stimulate it. Unfortunately the result of compulsory primary education has not been to promote any sense of responsibility in parents as regards this; at least that is my belief. And I may, I think, appeal to Scottish experience in support of it.

The institution of parish schools is, as is well known, older in Scotland than in England. They date there from the Reformation, and were part of the ecclesiastical organisation initiated by John Knox. In the scheme drawn up by him and his colleagues education had a great place. The parish schools, in which Biblical instruction was foremost, were put in charge of the Church and long needed its efforts for their maintenance. Starting in this way the zeal for school education had become traditional. All respectable parents aimed at giving their children the best education they could. There was a strongly rooted sense of duty in the matter, and this from a double motive. They sent their children to school not only to help them to get on in the world, but because of the traditional association of knowledge and religion. Observe the educational value of this second motive. I am not looking at it from the religious point of view—that is not my business to-day. But as an instrument of culture the value of a desire for learning, based on something other than its relation to worldly success, is obviously great. It may be that the school education actually prevailing in Scotland is better now than that of fifty years ago, that the examination of the school inspector is more searching, if less stimulating, than was that of the Presbytery, that the average or backward child is less sacrificed to the clever one than used to be the case, and that general intelligence is more developed. But the parents, who felt their children's schooling to be their private concern, valued it more, took more personal interest in it, and felt more personal responsibility for their children's progress than parents can do now. And it is a serious question whether the

loss of this close link with home life has not had a bad educational effect, taking education in its wider sense, which is not compensated for by possible improvement in the schools.

I must admit that in saying this I have in mind only a limited area. I have made no wider investigation. The population I am thinking of is an entirely rural one in a purely agricultural district in the south of Scotland, with which I was intimately acquainted as a young woman, and which I re-visit from time to time. In such a district compulsion to send the children to school was unnecessary. It probably was required in the large towns and the more industrial parts of the country. I do not complain of the introduction of compulsion, but it did strike me at the time of its introduction that it was of very doubtful advantage in my own part of the country, and this impression has not diminished since.

To see if it was shared by others I wrote to a friend, more familiar with the district than I am now, to ask whether he did not think that parental interest in the children's school education had decreased, and also whether he thought that, as judged, for instance, by the books they borrowed from the parish library, the grown-up population was less inclined to serious reading than they used to be. I received from him a very interesting reply. He agreed with what I have just said as regards the first question, and after speaking of the warm and genuine wish in old times to give the children a good education, added:—

"The parents might, indeed, let their older children be absent for short times from school for light farm work or the like. But this was more than made up for by the zeal with which they were sent to winter evening classes, which could be gathered then far more easily than now. It is an unfortunate effect of legislation that it has largely deprived us of the great asset we had in the keenness of parental interest. It came about in this way. Government made it compulsory that no child should be employed in wage-earning who had not passed the fifth standard. Almost instantly the ideal of our people was lowered. A child was "educated" who had passed the fifth standard! And when by and by Government made it compulsory that a child should be at school till fourteen years of age, the parents in many cases felt this hard upon them, and our School Board every year has applications for permission to children to work before they are fourteen on various pretexts. I do not say that our people are not interested in their children's education. They still inherit that interest. But *compulsion*, and the fact of the responsibility being taken by Government, has greatly changed their attitude."

With regard to my second question—"Whether there is in country parishes as much reading of serious books, books of weight, history, travels, etc."—he says he "must answer *No.*" He thinks that the young people are perhaps more intelligent than they used to be, "but the reading is in enormous proportion novels and very light literature." He goes on to tell me of an old man who died two years ago "of the finest old Scottish type—devout, independent, interested in religious reading, in lives of men like Livingstone, in travels (he was reading Nansen in his ninetieth year and most interested in his nearing the Pole). But the list of books in his steady reading from the library here was of quite different character from that opposite other names in our catalogue of the same rank." He says also that forty or fifty years ago good audiences could be got for lectures—historical, travel, etc., but that now a good audience can only be got for concerts, entertainments, or at most lectures with lantern pictures. All this seems, so far as it goes, to show a diminution in culture, in capacity for the higher intellectual pleasures, in fruitful curiosity. My correspondent is not prepared, however, to say that this change is due to changes in school education. It comes, he thinks, "of the different spirit in young people, less under authority, indulging more in pleasures, not pressing hard or thinking they need this in order to get on." He thinks, in short, that the young men now are more self-indulgent and less energetic than they were, and he looks to the nobler spirit which the war has called out to carry us into better ideals of life. He may be right in thinking that causes independent of school education have produced the result. But we must admit that if it is true that, concurrently with a school education improved in some important ways, there has been a diminution in intellectual interests—in culture, in short—the school education has at any rate failed in one of the objects aimed at.

Well, you must take these views about a particular country district for what they are worth. Facts observed among a comparatively small number of people may not represent the average. Moreover, my correspondent and I are both old—we could not remember, or think we remembered, the state of things fifty years ago if we were not—and you may, if you think proper, discount what we have to say, on the almost proverbial ground that old people put the Golden Age behind them. I am not, however, myself conscious of any such tendency. I believe very much in progress, and look forward to a gradually improving world, and I believe we are on the whole improving in educational ideals and educational methods as in other things. But it behoves us to watch what we do, and not to acquiesce, if we can possibly help it, in loss on one side without being very sure that it is more than compensated for by gain on the other. The loss of the parents' real co-operation where it has existed, and the failure to gain it where it has previously been absent, is serious. It is serious even if it is limited to the intellectual side of education and does not extend to the formation of character, as I fear it sometimes does. With the greatest zeal the schoolmaster cannot replace the parents, nor even the parents' influence in producing the right attitude of mind in the pupil. And it is at the very least doubtful whether the better teaching which improved methods secure to the pupil can make up for any loss of spontaneous desire to put his own mind into the effort of learning for learning's sake.

And so I come back to the point that the general public must be encouraged to take its share even in the part of education carried on at school and college, and in particular those members of the general public who are parents of pupils. But this conclusion is rather barren, for I have no very definite plan to suggest for carrying it out. The State cannot now, even if it would, abandon the responsibility for the elementary school education of the children, and even if it could it is more than doubtful whether it would be desirable. For though we have now secured that all parents shall themselves have had school education, we still cannot trust them all voluntarily to give that advantage to their children. So the drawback must be put up with that parents cannot feel the same degree of responsibility resting on themselves when the responsibility is undertaken by the State.

It is to be hoped, however, that we shall be very careful how far we entrust to the State the regulation of education higher than the primary. Bureaucratic regulation may be well adapted to produce German *Kultur*, but it is not the way to secure the attitude of mind which leads to freedom, independence of thought, and culture in the best sense. And it is very apt to lead to want of independence in the teacher.

Probably our best hope for progress in the right direction lies in movements like the Workers' Educa-

tional Association, where we have voluntary effort put forward to satisfy spontaneous desire to learn. As this movement extends we may hope more and more to get a generation of parents who, having themselves experienced intellectual curiosity and the joy of satisfying it, who, having themselves felt the gain of a wider outlook on men and things, may by their example inspire their children with a similar disinterested desire for learning and culture.

NOTES.

THE members of the Siberian Expedition sent out from this country sixteen months ago, at the joint expense of the Oxford University School of Anthropology and the Philadelphia University Museum, reached London last week. The leader, Miss M. A. Czaplicka, possessed exceptional qualifications for the work entrusted to her, being a native of Russian Poland, and a distinguished student of the Warsaw University and of Somerville College, Oxford. The expedition consisted of Miss Curtis, the artist, Miss Haviland, ornithologist, and Mr. Hull, of Philadelphia University, ethnologist. They proceeded from Warsaw to Krasniack, in Siberia, and thence to the mouth of the Yenisei. The first tribe examined was that of the Samoyeds, and then the winter was spent among the Tungus of the Tundra, a very primitive race, little influenced by Russian culture. The spring was devoted to the Tartars, who are much more civilised than either the Samoyeds or the Tungus. Much information of scientific interest has been acquired, and a large collection of costumes, weapons, implements, and ornaments made of copper and iron has been made. These will, it is hoped, be exhibited in Europe and America after the close of the war.

THE Admiralty Air Department has been reorganised and for the future will be under the direction of a flag officer, with the title of Director of Air Services. Rear-Admiral C. L. Vaughan-Lee has been selected for this appointment. He held the post of assistant to the Director of Naval Ordnance from February, 1899, to July, 1900, and of Assistant Director of Naval Intelligence from January to December, 1905. The Director of the Air Department, Commodore M. F. Sueter, C.B., has been promoted to the rank of Commodore 1st Class, and will be in charge of the *matériel* side of naval aeronautical work, with the new title of Superintendent of Aircraft Construction. Commodore Sueter was appointed Inspecting Captain of Airships in September, 1910, and in 1912 he was selected for the post of Director of the Air Department.

AN exhibition of the various forms of apparatus found most useful in the treatment of fractures met with in the war will be held in the premises of the Royal Society of Medicine, 1 Wimpole Street, W., from October 7 to 11. During the exhibition Sir Almroth Wright will demonstrate his recent researches in the drainage of wounds.

WE learn from the *Kew Bulletin* that Mr. W. G. Craib, assistant for India in the Kew Herbarium, has been appointed assistant to the professor of botany in the University of Edinburgh, with the status of University lecturer on forest botany and Indian forest trees, Royal Botanic Garden, Edinburgh. Mr. J. Hutchinson succeeds Mr. Craib at the Royal Gardens, Kew.

THE death is reported, in his eighty-second year, of Dr. Carlos J. Finlay, who was associated with the discovery of the part played by the mosquito in the transmission of yellow fever and other diseases. He was a native of Cuba, and received his general education at the Lycée at Rouen, and his professional education at the Jefferson Medical College, Philadelphia. He then returned to Cuba and became one of the leading physicians in the island.

THE death is announced in *Engineering* for September 10 of Mr. G. W. Manuel, who for twenty-one years was superintending engineer to the Peninsular and Oriental Steam Navigation Company. Perhaps his strongest characteristic was his determination that the P. and O. mail liner should reach its port according to scheduled time without the variation of a minute, and no development was made unless he himself was perfectly satisfied that it could be relied on and would conduce to punctuality. Mr. Manuel became a member of the Institution of Naval Architects in 1879, and contributed frequently to debates. His death will be regretted by many sea-going engineers who have come under his influence.

WE regret to see the announcement of the death, on September 14, at eighty-five years of age, of Sir John Knox Laughton, distinguished particularly by his studies in naval history. Sir John Laughton entered the Navy in 1853 as a naval instructor, and was mathematical and naval instructor at the Royal Naval College, Portsmouth, from 1866 to 1873. He was then transferred in the same capacity to the Royal Naval College at Greenwich, becoming also lecturer on meteorology. In 1885 he retired from active service on being appointed professor of modern history at King's College, London, and from that date until his death he devoted himself almost entirely to studies of naval history. In addition to valuable works upon this subject, he was the author of volumes on "Physical Geography in its Relation to the Prevailing Winds and Currents," and "A Treatise on Nautical Surveying." From 1882 to 1884 he was president of the Royal Meteorological Society.

JULIUS PAYER, the discoverer of Franz-Josef Land, whose death on August 31 was announced in our last number, was born in Bohemia in 1841. He served with distinction in the war with Italy in 1866, before he joined the second German expedition to east Greenland in the *Germania*, under Koldewey, in 1869. There he acquired much experience in polar work, in the exploration of King William's Land and the extraordinary Franz-Josef Fjord. In 1871, through the liberality of Graf Wilczek, Payer and Weyprecht undertook an expedition in the *Isbjörn* to Spitsbergen and the Barents Sea as a preliminary to an Arctic expedition on a large scale. This expedition, the first to explore the north of the Barents Sea, was fruitful of discoveries there and in Spitsbergen and Hope

Island. The Austro-Hungarian Arctic Expedition sailed in 1872 in the *Tegetthof*. Weyprecht was again associated with Payer in the command. Their aim was to push north-east of Novaya Zemlya and return to Europe *viâ* the Behring Strait. From the first they met with misfortune. The *Tegetthof* was beset in the ice in 76° 22′ N., 63° E., and drifted with the pack throughout the winter in hourly danger of destruction. Twelve months later high land was sighted to the north-west and named Franz-Josef Land. A landing was made on one of the islands. A second winter was passed on the ice-bound ship, and in the summer of 1874 Payer conducted several sledge expeditions to explore the new land. Passing up Austria channel, he reached Cape Fligely in Rudolf Land in 81° 51′ N. North-eastward he saw further land, which he named King Oscar and Petermann Lands. In May the *Tegetthof* was abandoned, and after terrible hardships to get clear of the ice the expedition reached Novaya Zemlya in open boats in August, 1874. An English version of Payer's narrative, "New Lands within the Arctic Circle," appeared in 1876. In 1875 Payer was awarded the patrons' medal of the Royal Geographical Society.

IN the course of excavations on the site of the great city of Pataliputra, the modern Patna in Behar, a discovery of much interest has been made. A vast pillared hall of the Maurya period, the third century B.C., has been unearthed. It contained eight rows of monolithic columns, fifteen feet apart, supporting a wooden superstructure which has been destroyed by fire. Some remarkable constructions of *sâl* wood beams have also been found, the object of which is uncertain; they may have been platforms for mooring boats, or supports for another portion of the building. The type of architecture at once recalls the great hall at Persepolis, and we have thus a further indication of the influence of Persian art on India during this period.

THE great Buddhist Emperor, Asoka, was in the habit of inscribing his edicts on monolithic pillars or on rocks throughout his wide dominions. The Buddhist pilgrim, Hiuen Tsang, mentions specifically sixteen such pillars. Up to the present ten have been discovered, but only two of these can be identified with those mentioned by the traveller. The rock inscriptions, of which twelve have already been found, though not possessing the artistic interest of the pillars, are in some respects the most valuable monuments of his reign. The recent discovery of another rock inscription by some gold prospectors at a place not far from Raichur, in the Dominions of the Nizam of Hyderabad, is now announced. The Government epigraphist, Rao Sahib H. Krishna Sastri, is satisfied that it is a rock inscription. As the texts of these documents vary, the publication of the inscription will be awaited with interest.

SOME admirable photographs of the adult and nestling of the Asiatic golden plover, and a most excellent account of the breeding habits of this bird, by Miss Maud Haviland, appear in the September issue of *British Birds*. The most important of her observations are such as concern the behaviour of apparently non-breeding birds of this species. On two points, however, she might well have been a little more explicit. The reader is left in doubt, for example, as to whether the newly-hatched nestlings accompany their parents, from the high to lower grounds, to participate in the formation of the flocks of which she speaks, and it would have been helpful to have had a more precise description of the plumage of the fledgling. Following Miss Haviland's paper comes a brief account, by Mr. C. W. Colthrup, of the idiosyncrasies of the nidification instinct in the redshank. Within the confines of the same marsh in Hampshire he found eggs in comparatively elaborate nests and screened from view by overarching stems of grass, while in other cases the eggs were laid in an apology for a nest, and without any attempt at concealment.

IN the *Philippine Journal of Science*, vol. x., No. 1, Mr. R. P. Cowles contributes some extremely interesting notes on the habits of some tropical Crustacea. He deals more especially with the remarkable feeding habits of *Atya molluccensis*, and of several species of Caridina, and the peculiar structural modification of the chelæ associated therewith. In both genera the chelæ or "nippers" are armed with hairs, which, in Atya, can be opened to form funnel-shaped strainers for the capture of minute organisms, and closed to form a pencil-like brush, imprisoning the food thus captured, which is then conveyed to the mouth. While feeding, Atya, which is an inhabitant of running streams, remains perfectly still, with its strainers directed upstream. Caridina, with similarly armed chelæ, crawls about on the bottom of the stream, and uses the hairs, not as strainers, but as brushes, to sweep the bottom of the stream for minute particles of animal and vegetable matter. Mr. Cowles supplements these notes with valuable observations on the habits of *Myctris longicarpus*, which appears in countless numbers on sand-banks exposed at low tide. When the tide rises they immediately disappear beneath the sand. During their migrations they are continually smearing the sand over the mouth with the chelæ, apparently for the sake of the nourishment to be derived from the particles of animal matter it contains. These creatures are extremely difficult to approach, for on the slightest alarm they at once proceed to dig themselves into the sand, vanishing in about three seconds.

THE recently issued part of Contributions from the United States National Herbarium, vol. xvii., part 6, is entirely occupied by an enumeration of the tropical North American species of Panicum by A. S. Hitchcock and Agnes Chase. One hundred and sixteen species and three subspecies are included, nine of which are new. The total number of species of Panicum in North America is now 216. Each species is accompanied by an outline map graphically representing its geographical distribution within the tropics of North America. There is also a key to the species and groups, and a complete list of the localities for each species is given.

A CATALOGUE of the soft-water algæ collected in the Caucasus in the region of Czernomorsk is published

by M. A. I. Lobik in the Bulletin of the Imperial Botanic Garden of Peter the Great, vol. xv., No. 1, 1915. Sixty-five species are enumerated; they include one Floridean alga, *Batrachospermum moniliforme*, one brown alga, *Hydrurus foetidus*, twenty-five Chlorophyceæ, twenty-four diatoms, and fourteen members of the Cyanophyceæ. Among the Chlorophyceæ a new form of Spirogyra and of Cosmarium are described, and also a new genus, Leptobasis, among the Cyanophyceæ. This new alga, *L. caucasica*, forms the subject of a separate memoir by M. A. A. Elenkin, who, with M. V. P. Savicz, made the whole collection. Elenkin, in determining the new genus, revises the old genus Michrochæte, and considers that the genera Michrochæte, Coleospermum, and Leptobasis should be classed in different sections of the Hormogoneæ. The paper is illustrated with text figures.

IN the *Philippine Journal of Science* for May (vol. x., No. 3), Mr. E. D. Merrills contributes four papers dealing with Philippine botany, and describes a number of new species of the genera Schefflera and Eugenia. In the opening paper on the present status of botanical exploration in the Philippines, which is illustrated by a map of the group, Mr. Merrill gives interesting particulars showing the amount of work which has been accomplished during the past thirteen years, and the parts of the archipelago which have been thoroughly explored. Compared with Java, Singapore, and Penang, the flora is not well known, and though much work has been done it has been confined to a few definite areas in Luzon and Mindanao. The islands are so densely forested that even in those regions visited by botanists on short excursions only a tithe of the plants has probably been collected, and a large number of endemic forms doubtless await discovery. Some fifteen years ago 2500 species of flowering plants were recorded from the islands; now the number is estimated at rather more than 7000, and it seems probable that 10,000 species is not an extravagant estimate for the phanerogamic flora of the Philippines. Some 40 per cent. of the whole Malay Archipelago flora will probably be found to be endemic in the islands.

TARE-LIKE rogues appear from time to time among culinary peas, and are characterised by the possession of stipules and leaves narrower and more pointed than those of normal plants. The pods also are distinct, since they are always curved and narrow, even though the races in which the rogues have arisen bear straight pods, and the seeds are less sweet than those of the types. The seed-raiser has attempted to eliminate the rogues by destroying them as they appear, but all to no purpose; the rogue still reappears, and with the object of understanding its origin and finding a means of control, Mr. Bateson and Miss Pellew have conducted a series of investigations at Merton, and have published their results in the *Journal of Genetics* (vol. v., No. 1) for July. Though the research has been extended and a large series of plants examined, the origin of the rogue is still a mystery, nor has a method been devised as yet for the elimination of these tare-like plants. Rogues may depart widely or only slightly from the type; in the latter case rogue characters may only appear in the youngest parts, but as such plants can produce complete rogues among their offspring they should be weeded out. Rogues in breeding beget only rogues, and even in a strain of quite normal plants rogues occasionally appear. One remarkable result of the inquiry is that normal plants crossed with rogues always give rogues, and this was found to be true in fifty out of fifty-two crosses, and to persist through three generations.

THE methods of bacterial analysis of air have recently been investigated by Mr. G. L. Ruehle in the course of an inquiry into the contamination of the air of cowsheds and its effects on the milk supply. In vol. iv., No. 2, of the *Journal of Agricultural Research*, a large number of comparative analyses is described in detail. Three forms of apparatus were used: (1) the standard sand-filter aeroscope of the American Public Health Association; (2) a modification of the standard designed by the author to permit sterilisation by dry heat; and (3) the Rettger liquid-filter aeroscope. The efficiency of the aeroscopes was tested by running two of each type in tandem so that the air passes through one filter and then through the other. The percentage of the total number of bacteria caught by the first filter determines the efficiency. The standard aeroscope was found to have a very variable efficiency, averaging 90 per cent., but the modified standard retained nearly 100 per cent. of the bacteria. The Rettger apparatus also gave excellent results, but required greater care in manipulation, as difficulties occur with foaming of the liquid during filtration and the tenacity with which the bacteria cling to the inner surface of the moist inlet tube. The method of determining bacterial precipitation from air by exposing Petri dishes is quite untrustworthy, as it only measures the number of bacteria-laden dust particles falling on the plate. The exposure of sterile water in pails gives an average bacterial count ten times higher than that obtained by the plate method.

WE have received vol. xxvi. of the *Anales* of the National Museum of Natural History of Buenos Aires, containing a useful index to the first twenty volumes of this publication (1864–1911), and an interesting illustrated account of the fine new building for the museum which it is hoped will soon be provided by the Argentine Government. Under the energetic direction of Dr. Angel Gallardo, the technical scientific work of the museum has become very varied, and the newly-published volume contains several valuable contributions to systematic zoology and botany. There is also an exhaustive study of the collection of human skulls from Patagonia, with numerous tables of measurements. The most generally interesting research is a new examination of the deposits on the coast of the province of Buenos Aires containing human remains or implements made by man. This has been instigated by the criticisms of Argentine discoveries published by Drs. Hrdlička, Holmes, and Willis in their work on "Early Man in South America" (Smithsonian Institution, 1912). It is maintained that in the neighbourhood of Mar del Plata and Miramar there is no reason to doubt the association of evidence of man with late Tertiary

mammals, and a femur of a small Toxodont is described by Mr. Carlos Ameghino, showing a piece of worked quartzite which must have penetrated the bone during life.

THE Avezzano earthquake of January 13 last originated in a portion of Italy in which strong earthquakes are of infrequent occurrence. One of its latest predecessors, that of February 24, 1904, has been studied by Dr. A. Cavasino (*Boll. Soc. Sis. Ital.*, vol. xviii., 1914, pp. 411–48), and his conclusions are of interest in connection with the recent earthquake. The area of destruction contains only 54 square miles, and its centre lies about seven miles north-west of Avezzano. The two earthquakes were therefore in all probability associated with the same fault. As the disturbed area includes only about 4750 square miles, the focus cannot have been at a great depth. Using Dutton's method, Dr. Cavasino estimates that depth to be about 4½ miles.

A SUMMARY of the weather for the past summer is given in the issue of the Weekly Weather Report of the Meteorological Office. The period comprises the thirteen weeks from May 30 to August 28, and the aggregates of temperature, rainfall, and bright sunshine are given for the several districts of the United Kingdom. The mean temperature was below the average everywhere except in the north of Scotland, where the excess was less than 0·5°; the deficiency amounted to a degree in the south-east and south-west of England, and in the English Channel, whilst in other districts it was generally about 0·5°. The east of England was the only district with the absolute maximum temperature as high as 90°, and in all the western districts the thermometer failed to reach 80°. Rainy days were in fair agreement with the normal, whilst the total rainfall varied considerably in different parts of the United Kingdom. There was a deficiency of rain in the north and west of Scotland, the north of Ireland, the north-west and south-east of England, and in the English Channel; the greatest deficiency was in the west of Scotland, where the rainfall was only 72 per cent. of the average. There was an excess generally in the eastern district, in the south-west of England, and in the south of Ireland; the greatest excess was 123 per cent. of the average in the east of England. Bright sunshine differed very little from the normal, and the only districts with an excess were the north of Scotland and the north-west of England.

THE number of the Proceedings of the Tokyo Mathematico-Physical Society issued in June, 1915, contains a *résumé* in English by Mr. Tokurô Nakano of a magnetic survey of Japan for the epoch January 1, 1913, executed by the Japanese Hydrographic Office under the superintendence of Prof. Tanakadate. There were four survey parties in the field, and the whole of the observations were concluded within fourteen months, so that uncertainties arising from secular change were unusually small. A previous survey had been made for the epoch January 1, 1895, also under the supervision of Prof. Tanakadate, and the same instruments and a good many of the same stations were employed on the two occasions. A still earlier survey was executed in 1887 by Profs. C. G. Knott and Tanakadate. The 1913 survey, however, unlike the earlier ones, was not confined to Japan proper. Of its 331 stations, 78 were in Korea and 16 in Formosa; 38 of them were adjudged disturbed and left out of account in deducing the isogonals, isoclinals, and isodynamics. Formulæ were found for the values of the different magnetic elements, proceeding in powers of the latitude and longitude differences. Tables based thereon give the calculated values of the declination, dip, and horizontal force at the intersections of degrees of latitude and longitude. Similar formulæ were found for the secular change, and even for the rate of change, or "annual acceleration," of the secular change. The secular change conclusions were based on the results from fixed magnetic observatories and from stations common to two or more of the surveys.

THE Transactions of the Royal Society of South Africa, vol. iv., parts 1 and 3, 1915, contains three papers by Prof. J. C. Beattie dealing with terrestrial magnetism in South Africa. The first paper, read July 16, 1913, gives the values of declination, dip, and horizontal force observed by Prof. Beattie himself at about ninety stations in the years 1910 to 1913, and values of the declination observed by Mr. O. C. Macpherson at seven stations in 1909. Some of the ninety stations had been previously observed at by Profs. Beattie and Morrison during their survey of the epoch July 1, 1903. The new parts of the country dealt with included the West Transvaal, British Bechuanaland, and Bushmanland. The second paper, also read on July 16, 1913, gives a table of values of declination, dip, and horizontal force for the epoch July 1, 1908, at 255 South African stations. The observations had been made at various times from 1900 to 1913, the reductions to a common epoch depending on the secular change results obtained from repeat stations. There are three charts representing respectively the isogonals, the isoclinals, and the lines of equal horizontal force for the epoch considered. The third paper, read May 20, 1914, discusses the secular variation of the magnetic elements in South Africa between 1900 and 1913. There are three charts showing respectively the mean annual changes of declination, dip, and horizontal force. Westerly declination is falling throughout the whole of South Africa, the rate of fall being especially large—from 10′ to 13′ annually—along the east coast as far north as Mozambique. The southerly dip is increasing rapidly, but in this case the rate of change is largest—8′ per annum—in the neighbourhood of Cape Town. Horizontal force is diminishing rapidly, the annual fall in Cape Colony varying from 85γ to 100γ per annum. There are few parts of the world where so large secular changes have been observed, thus magnetic observations in South Africa are of exceptional value.

THE London Mathematical Society has issued, with the assistance of its official printer, Mr. T. T. Hodgson, a list of suggestions for notation and printing of mathematical formulæ, accompanied by a sample illustration showing the leads, spaces, and quadrats required in mathematical composition. Most of the suggestions might be summed up briefly in the

general statement that every symbol or sign introduced at a different level to the rest involves extra spacing, although this objection does not apply to the use of the ordinary indices and suffixes, or to the use of two lines to represent fractions in a line consisting entirely of formulæ. The use of a bar over a square root is objectionable, but we would suggest that the proposal always to use Roman or Greek *i* for the root of -1 is scarcely necessary, as the bar can be omitted in this case without ambiguity. The use of fractions in the middle of a line of letterpress produces an unsightly result. While agreeing with the suggestion that the small numerical fractions which are usually cast as single pieces of type can often be used with advantage, it should be noticed that "thirds" are not easy to distinguish from "eighths," and the solidus notation may often be used to overcome this difficulty. The avoidance of letters with bars or dots placed above them, to which much importance is attached, is a change which may often present difficulty, and it is doubtful how far the proposal to substitute dashes in the fluxional notation will be found practical in view of the frequent use of dashes for other purposes. There is, however, no reason why the raised dots should not be placed after instead of over the letters, while inverted commas offer another new opening, hitherto neglected. We should like to see "exp." included in the list of suggestions. But if writers of papers are sometimes to blame, printers have an awkward way of beginning a formula at the end of one line of letterpress and continuing it in the next line, even when the author has not done so. And we think the printers might at least take on themselves the responsibility of removing the bars over square roots. When, however, a paper refers to the rigid dynamics of aeroplane motions, the number of symbols required is so great that violation of every rule becomes inevitable.

IN the second part of vol. iv. of the Science Reports of the University of Sendai, Prof. K. Honda describes a balance which allows the effect of temperature on any chemical change involving loss of material by evaporation or dissociation to be followed readily. The beam of the balance is a silica glass tube from one end of which a small platinum or magnesia vessel to contain the specimen is suspended, within an electrical heating coil enclosed in turn in a Dewar vacuum vessel. The other end of the beam is pulled down by a spiral spring, the pull of which can be adjusted to suit the specimen used. The movement of the beam is observed by means of a mirror attached to it and a telescope and scale, a deflection of a millimetre corresponding to about half a milligram. The temperature of the specimen is observed by means of a thermo junction, and is raised about a degree per minute. Curves showing the loss of water of crystallisation of two sulphates, the dissociation of a carbonate, and the change of chromic oxide with temperature are given.

"RED BOOK" No. 198 of the British Fire Prevention Committee contains the report of a fire test with three window openings filled with wired glass. These were subjected to the committee's standard 60-minute test at temperatures reaching up to 1600° F., followed by the application of water under pressure. The usual test size of glazed panels is about 2 ft. by 2 ft., but one of the panels under test in this case measured about 3 ft. by 2 ft. The classification of temporary protection (Class B) under the committee's standards has been accorded for this glazing to this larger size. Partial protection (Class A) has already been obtained for wired glazing by the same makers (Messrs. Pilkington Brothers, Ltd., St. Helens), both for regulation sizes and for a panel measuring about 4 ft. by 1 ft. In the present tests, in the case of two of the panels, neither fire nor water had passed through the glazing at the conclusion of the test, and the glazing remained in position after the application of water. In the third panel (two lights) fire had not passed through the glazing, but on the application of water the glazing in the lower light was perforated at the top portion, and some water came through. In this case also the glazing was in position after the application of water.

MR. JAMES HORSFALL, late chief draughtsman of the Canadian Pacific Railway, suggests an improvement in the design of locomotive coupling and connecting rods. Such rods are subject to reversal of stresses due to the alternate push and pull, and also in the bending due to the action of centrifugal force. The effects of the latter may be reduced considerably by prolonging the rods beyond the pins and attaching balance weights to the extensions so formed. By suitably adjusting the proportions, the bending moment at the middle of the rod may be made zero, and the maximum bending moment on the rod will be much less than in the same rod unbalanced. Mr. Horsfall says that, as the result of very numerous experiments with rods of various kinds, he is convinced that the best way to avoid danger from the breakage of coupling and connecting rods is to counterbalance them in the manner suggested.

OUR ASTRONOMICAL COLUMN.

COMET 1915*d* (MELLISH).—The discovery of a second comet during the present year by Mr. J. E. Mellish, Madison, Wis., U.S.A., was announced last Thursday in a telegram from Copenhagen. On September 6, at 22h. 9·1m., the comet's position was α 6h. 30·2m., δ 8° 50′ (approx. 8° south of γ Geminorum). No information was supplied regarding the direction or rate of the comet's motion, or of its magnitude.

SATURN.—Dr. Percival Lowell, in a letter to M. Flammarion (*L'Astronomie*, August, 1915), describes observations made at Flagstaff during last spring. Photographs were secured on March 12, when the ring system was practically at maximum apparent breadth. Cassini's division appeared continuous. With the planet thus framed in its rings a new determination of the aplatissement has been possible, giving the value 1/9·18

RADIAL VELOCITY, MAGNITUDE, AND SPECTRAL TYPE.—Mr. C. D. Perrine has published (*Astrophysical Journal*, vol. xli., pp. 396–99) the results of further analysis of the data in Campbell's lists of radial velocities. Dividing the stars into two groups according to magnitude, drawing the line at 3.0m., he finds a decided increase of the mean radial velocity for the fainter group; this also holds for the stars of each

spectral type separately (except only the A stars), and the effect appears to be more marked in the later types. Further, the highest known velocities are found in the vicinity of the Milky Way. It is conjectured that the effect may be due to the operation of a resisting medium on stellar bodies differing in size and density, or the closer proximity of the fainter stars to a "source of general gravitational action." In either case the Milky Way would be deeply concerned.

In another note in the same journal Mr. Perrine analyses the spectral distribution of the stars of large radial velocity, finding the maximum mean values among the faint stars of classes F and G.

VOLCANIC DUST VEILS AND CLIMATIC VARIATIONS.—Fluctuations in the observed intensity of the solar radiation have been interpreted during the past ten years or so as traceable to the screening effects of the enormous quantities of dust poured into the upper atmosphere during notable volcanic eruptions; thus it has been a small step to the wider hypothesis that volcanic dust has been a possibly important factor in the production of past climatic changes. This hypothesis is tested by Mr. Henryk Arctowski in a paper communicated to the New York Academy of Sciences (Ann., Vol. xxvi., pp. 149–174, June, 1915). Previous work on temperature records had led him to the conclusion that a general rise in the temperature of the atmosphere was probably due to an increase in the solar constant itself. From a re-examination of temperature curves, chiefly showing departures from monthly means, paying special attention to the epochs of the Krakatoa (1883) and Katmai (1912) eruptions, as well as the year 1902, which was marked by intense vulcanism in both hemispheres, he now concludes that the short-period variations of temperature have nothing in common with the presence or absence of volcanic dust veils, although minor secondary modifications of the temperature curve may sometimes be traced to this cause. He finds that the sun-spot variation does appear to have an influence on atmospheric temperature, and, moreover, presumes, but does not explain, the existence of a correlation between the temperature changes and frequency of volcanic eruptions.

THE AURORA BOREALIS.—An illustrated account was given in NATURE, August 7, 1913, of the photographic observations made by Prof. Carl Stormer, in collaboration with M. Bernt I. Birkeland, in the spring of 1913. These observers were stationed at Bossekop and Store Korsnes respectively. They secured a great wealth of parallax material which will require a long time for reduction. However, one-sixth having been finished, Prof. Stormer has published a preliminary report ("Terres. Mag. and Atmos. Elec.," vol. xx., No. 1). Some six hundred measures of altitude have been worked out, most of the measured points lying between 90 and 130 km. above the earth's surface; none come out appreciably lower than 90 km., whilst the highest reaches 230 km. From a mere inspection of the diagram the mean height appears to be about 120 km.; thus the lower limit is fairly well marked. The spatial relations of a number of auroral curtains have been worked out in detail. In one case this information has been used in conjunction with magnetograms from the Haldde Observatory, to obtain an idea of the nature of the aurora. The curves show that the magnetic effect due to the passage of the particular auroral feature had components directed N.W. and upwards. On the assumption that the display was caused by electric corpuscles travelling towards the earth, Ampère's rule indicates that the observed deflections would result from the motion of particles carrying a positive charge.

AMERICAN HYDROIDS.[1]

MR. NUTTING may be congratulated on the completion of the third part of his great monograph on American Hydroids. He has a generous conception of America, and includes in his list such species as *Sicularia hemisphaerica* from S. Tierra del Fuego and *S. repens* from Kerguelen. It is therefore almost a monograph of the hydroids of the world, and will be regarded as the most important work of reference on the group that has yet been published. Those who are specially interested in Cœlenterata will probably be gratified to find that Mr. Nutting has taken a conservative attitude as regards species, and that, notwithstanding the many temptations to which he has been exposed in the course of his vast labour in this field, he has added very few new species to those already recognised. It is a much easier method—and a particularly attractive one in the preparation of a standard treatise on systematic zoology—to make new species when difficulties arise than to exercise the skill and patience that is required to place doubtful specimens in their proper specific groups, and we may regard it as a sign of Mr. Nutting's knowledge and thoroughness that the list of species is not a longer one.

The method adopted in dealing with the species is to select a specimen regarded by the author as typical, to give in a footnote the locality from which the specimen came, and then to describe it in detail. There is much to be said for this method in dealing with the systematics of Cœlenterata, because it gives the systematist a fixed point, as it were, around which the variants may be grouped, but it seems to us that to that description of a type some statement should be added of the principal variations observed by the author in the species under consideration in order that future workers in the group may find that some of the difficulties they are sure to meet with in using the monograph as a standard work of reference have been anticipated by a recognised authority.

The author has evidently taken infinite pains to collect from all available sources specimens of American hydroids for study and description, and his reference lists at the head of each species are extraordinarily complete and accurate. Our thanks are due to him for a very valuable work. S. J. H.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Board of Education informs us that the regulations and syllabuses which governed the examinations in science and technology held in 1915 will continue in force for 1916. In the prefatory note to the volume of regulations and syllabuses for examinations in science and technology, 1915, the Board announced its intention to discontinue those examinations at a date to be afterwards announced. The Board now gives notice that after 1916 it will no longer hold lower general examinations in any subjects of science and technology. The higher general examinations will for the present be continued.

THE prospectus for the forthcoming session of the Belfast Technical Institute has now been published. An interesting departure is the indication by an asterisk prefixed to the name of the members of the permanent staff who are at present serving in the Army or Navy, or who are engaged on war service. The number of asterisks is excellent testimony to the

[1] "American Hydroids." Part III. The Campanularidæ and the Bonneviellidæ. Smithsonian Institution. Special Bulletin. Pp. 126+70 text figures+27 plates. Washington, 1915.

loyalty of the staff. The prospectus follows the general lines of previous years, and is, as usual, profusely illustrated. The Queen's University of Belfast and the Corporation of Belfast have entered into an agreement whereby the Technical Institute is recognised as a college in which students of the University may pursue a course, or part of a course, of study qualifying for a degree or a diploma of the University. The degrees obtainable are those of bachelor, master, and doctor of science. The departments recognised are those of mechanical and electrical engineering, chemical and textile technology, architecture and naval architecture. The day technical college has been established to provide instruction in the science and technology of mechanical and electrical engineering, the textile industries, and pure and applied chemistry, and gives a sound training for youths who aim at filling positions of responsibility in the various industries. Belfast may be congratulated upon the enterprise which has resulted in the establishment of an institution in which its young citizens can equip themselves fully for their parts in the industrial life of the community.

THE new session of the Battersea Polytechnic opens on September 21, and particulars of all the courses and classes are given in its calendar, which is now available. Full day and evening courses in preparation for the University of London intermediate and final degree examinations in science, engineering, and music have been arranged. In the day technical college, courses are arranged in mechanical, civil, electrical, and motor engineering, architecture and building, and chemical engineering. The training department of domestic science offers courses in preparation for the teachers' diploma in domestic subjects. The department of hygiene and physiology provides complete courses in training for women sanitary inspectors and health visitors. Full evening courses are provided in the various departments. In addition to its usual work, the polytechnic has adapted itself to meet the needs occasioned by the war, and the following will give some indication of what is being done:—Special Red Cross courses in first aid, home nursing, cookery, and laundrywork for women are being held. Belgian refugees are admitted to classes free of fee, and many such students have taken the motor-car engineering course, with a view to war service in France or Belgium. The mechanical engineering department is engaged in the manufacture of munitions, and the chemical department on the preparation of chemical substances for the Government. So far as is known at present 384 members of the polytechnic governors, staff, and students have joined the Forces, and at least forty-three of these hold commissions.

THE calendar for the next session, which is the hundred and twentieth, of the Royal Technical College, Glasgow, has reached us. It will be remembered that in 1913 the college was affiliated to the University of Glasgow. Candidates for the degree of B.Sc. in applied science may attend the necessary qualifying courses either in the University or in the college, or in both. A noteworthy testimony to the value of the instruction given at the college is its recognition by various professional bodies and Government departments. Thus, success in the civil engineering courses exempts from the examinations of the Institution of Civil Engineers; the college has been recognised by the Board of Trade as suitable for the training of marine engineers; the Home Secretary has approved the college course of study in mining engineering, and holders of the college diploma or B.Sc. degree in mining are entitled to the exemption authorised by the Coal Mines Act, 1911; the college is on the register of the Institute of Chemistry; and other instances could be given. The governors of the college have succeeded in securing the co-operation of employers. The calendar contains a long list of firms willing to allow a selected number of their apprentices facilities for carrying out a scheme of college study conjoined with practical work; and many Clyde shipping companies have promised to give special consideration to applications for employment from men who have gone through the college course in navigation. The work of great technical colleges like this institution is of vital national importance, and it may be hoped it will receive from the State the recognition it deserves.

THE acting registrar of the University of Durham has sent us a list of the members of the staff of the colleges of the university now serving with H.M. Forces to supplement the lists given in NATURE of July 15 and in other issues. The list includes fifty-five names, twenty of which are of members of the staff of the College of Medicine, Newcastle. We give the names only of members of the scientific staff on active service. *Durham Division*:—P. A. Brown, lecturer in economics, 2nd Lieut. 13th D.L.I.; F. C. H. Carpenter, lecturer in astronomy and observer, Lieut. 8th D.L.I. *Newcastle Division* (*Armstrong College*):—J. Gallon, prize demonstrator in mining, 2nd Lieut. R.F.A.; F. C. Garrett, lecturer in chemistry, Lt.-Col. N. Cyclists; A. A. Hall, assistant lecturer in agricultural chemistry, Lieut. 5th N.F.; H. M. Hallsworth, professor of economics, 2nd Lieut. O.T.C.; T. H. Havelock, professor of applied mathematics and mathematical physics, 2nd Lieut. O.T.C.; W. B. Little, instructor in horticulture, 2nd Lieut. 9th D.L.I.; H. Morris-Airey, lecturer in physics, Lieut. R.N.V.R.; J. Morrow, lecturer in engineering, Major, O.C., O.T.C.; A. D. Peacock, lecturer in zoology, Sergt. R.A.M.C.; J. H. Poulton, prize demonstrator in physics, Sergt. 9th N.F.; J. W. Ramsbottom, lecturer in commercial and industrial economics, Lieut. 20th Manchester Regt.; J. Small, demonstrator in botany, Corpl. R.A.M.C.; L. A. Thompson, lecturer in agricultural surveying, Lieut. 7th D.L.I.; L. M. Thompson, prize demonstrator in geology, 2nd Lieut. 11th N. Staffs.; T. Whitehead, assistant lecturer in agricultural and forest botany, Capt. O.T.C.; D. Woolacott, lecturer in geology, 2nd Lieut. O.T.C.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 6.—M. Camille Jordan in the chair.—A. **Lacroix**: A new type of alkaline granitic rock containing a eucolite. This rock was found at Ampasindava (Madagascar), and belongs to the eudialyte-eucolite group, containing zirconia (16·4 per cent.), and the oxides of cerium, lanthanum, and didymium (22·5 per cent.).—J. **Boussinesq**: The effect of a gradual contraction in a water main on the pressure in the contracted portion. A mathematical discussion of the Venturi effect.—Charles **Richet**: The stimulating action of magnesium salts on the lactic fermentation. The maximum effect on the lactic fermentation is produced by 12·5 grams per litre of crystallised magnesium chloride, $MgCl_2,6H_2O$, very near to the concentration of the same salt found by P. Delbet to exert the maximum effect on phagocytosis.—Paul **Vuillemin**: The morphological value of the corona of the Amaryllidaceæ.—Pierre **Delbet** and M. **Karajanopoulo**: Cytophylaxy. In the defence of the organism against infection the protection of the blood cells (cytophylaxy) is at least as important as the use of antiseptics, and the present paper gives an account of experimental studies of the action of the various solutions employed in the treatment of wounds on the

living cells of the blood, studies specially aimed at finding out any substance capable of increasing the phagocytic properties of the white corpuscles. Most of the antiseptics in current use reduce the phagocytic power; the best results were obtained with a solution of magnesium chloride containing 12·1 parts per 1000. This solution has a marked effect in increasing phagocytosis.—F. **Baldet**: The helicoidal filaments of the Morehouse comet (1908*c*). The electromagnetic interpretation of the forms of the filaments leads to attributing them to jets of electrons emanating from the nucleus and illuminating the gases of the tail of the comet during their passage.—M. **Auric**: A quadruple series of hexahomologic triangles.—Nicolas **Lipine**: The reduction of the periods of Abelian integrals and a generalisation of Abel's theorem.—B. **Galitzine**: An apparatus for the direct determination of accelerations.—Ed. **Delorme**: The ligature of the external iliac artery.—F. **Bordas** and S. **Bruère**: The action of the ferments of urea in the destruction of organic material.

New South Wales.

Linnean Society, July 28.—Mr. A. G. Hamilton, president, in the chair.—M. **Aurousseau**: Petrological notes. No. 1—Igneous rocks and tuff from the Carboniferous of New South Wales. Eleven rocks are described from three localities in the Hunter River Valley. The mode of origin of the rocks described is not yet settled. From internal evidence, they would appear to be volcanic. But Prof. David has recently met with an interesting section near Wallarobba, showing Martin's Creek andesite strongly intrusive, as a sill, into the Carboniferous sedimentary rocks; and he is of the opinion that sill-structure is more extensively developed in the Carboniferous rocks than has been supposed.—Dr. V. F. **Brotherus** and the Rev. W. W. **Watts**: The mosses of Lord Howe Island. Twenty-two species are described as new, as well as some new varieties, and many new records are given, some of which link up the flora of the island with that of the Northern Pacific. All the species recorded were collected by Mr. Watts in 1911.—G. I. **Playfair**: Fresh-water Algæ of the Lismore District; with an appendix on the algal fungi and Schizomycetes. This paper deals with the algæ and algal fungi collected, for the most part, from lagoons, swamps, rain-water pools, and roadside ditches almost entirely within the boundaries of the city of Lismore, during 1914. The fresh-water forms of the Richmond River, at Lismore, were treated of in a paper published last year. The total number of forms recorded from the river was 305; the corresponding number of the land-forms is 308 (of which 207 are additional to those recorded from the river). As the land-forms were collected over an area of about two miles in diameter, the grand total of 512 may be regarded as indicative of a rich microflora. —A. A. **Hamilton**: Topographical and ecological notes on the flora of the Blue Mountains. This paper deals with the range of the plants to be found on the Blue Mountains, in regard to elevation; and about 400 species are listed. The area selected is that between the Hawkesbury-Nepean and Eskbank, a region which includes the highest and lowest elevations on the mountains. It is shown that King's Tableland is a barrier, east and west, which checks or entirely prevents the ascent or descent of many species.

BOOKS RECEIVED.

Memoirs of the Geological Survey. Summary of Progress of the Geological Survey of Great Britain and the Museum of Practical Geology for 1914. Pp. iv+84. (London: H.M.S.O.; E. Stanford, Ltd.) 1*s*.

Memoirs of the Geological Survey. England and Wales. Explanation of Sheets 330 and 331 (Mainland). The Geology of the Country near Lymington and Portsmouth. By H. J. O. White. Pp. v+78. (London: H.M.S.O.; E. Stanford, Ltd.) 1*s*. 6*d*.

The Royal Technical College, Glasgow. Calendar, Session 1915–16. Pp. 516+xxxviii. (Glasgow: Royal Technical College.) 1*s*.

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THURSDAY, SEPTEMBER 23, 1915.

THE CITIZEN AND THE STATE.

(1) *Morals in Evolution: a Comparative Study in Comparative Ethics.* By Prof. L. T. Hobhouse. Pp. xvi+648. Third edition. (London: Chapman and Hall, Ltd., 1915.) 10s. 6d. net.

(2) *The Natural History of the State: an Introduction to Political Science.* By Prof. H. J. Ford. Pp. viii+188. (Princeton: University Press; London: Oxford University Press, 1915.) 4s. 6d. net.

(3) *Citizens To Be: a Social Study of Health, Wisdom, and Goodness, with Special Reference to Elementary Schools.* By M. L. V. Hughes. Pp. xvii+331. (London: Constable and Co., Ltd., 1915.) 4s. 6d. net.

(1) THE present world-struggle is likely to have among its far-reaching results a modification more or less profound in our concepts of both the bases and the standards of civilisation, of morality as a whole, of the State, and of education. Cultural values are in the crucible. The German point of view in each should not be either ignored or over-estimated; the German theory and practice of *Kultur* in war serves as a critical test and ordeal for Western civilisation generally. We speak of German immoralism and "Prussianism"; the Germans describe our own characteristic methods as hypocrisy and "muddling through." Whether these distinctions, if real, are the same as those between perversion and orthogenesis, autocracy and freedom, is an open question, but we can certainly learn from the enemy the lesson of applying science to every department of civilised life and organisation. And, after all, whatever the ideals of a people, it is doomed to stagnation unless its science is living, and is continuously informing every activity of national life. This may be considered an academic truism by the practical man, who is too often the unscientific man; but a truism is none the worse for being academic, and, if true, deserves a trial. The Germans have had the insight to try it, and they have had extraordinary successes therefrom. If these do not continue, it will be the fault, not of the application of science, but of German character and circumstances.

Some thinkers may have noticed how German crimes against human and international morality, such as the destruction of Louvain and the sinking of the *Lusitania,* have passed into somewhat of oblivion in the consciousness of neutral States and bodies, such as the U.S.A. and the Vatican, with a rapidity directly proportional to that of the immediate indignation which they aroused. It may be argued that this phenomenon is due to the absence of retribution, and the argument would be a significant criticism of world-morality. Prof. Hobhouse, in the new and third edition of his "Morals in Evolution," devotes some five pages to the question of punishment, whereas Prof. Westermarck, in his "Origin and Development of the Moral Ideas," devoted about a quarter of his space to it, roughly speaking, about five hundred pages. The significance of this contrast is perhaps to be found in the fact that the outlook of Prof. Hobhouse is philosophical, from the concept, that of Prof. Westermarck is from emotion. Of course, these views are not mutually exclusive, but most usefully mutually subservient. Prof. Hobhouse has practically rewritten his book, and has incorporated in it the investigations into the culture of the "simpler peoples," carried out by himself and Messrs. Ginsberg and Wheeler. This anthropological research on statistical lines enormously increases the value of the book. As before, the author's broad outlook is eminently sane; if he retains any prejudice, it is Hegelian, but one must have an absolute of some sort.

"That the moral standard of man is based on the character of man . . . is a principle which has been little understood in modern ethics." In order to see the genesis of morality the author goes to instinct. Instinct "is a name for human character as it grows up under the conditions of heredity, and it is from this character, with all the faults and foibles along with the virtues thereof, that the moral judgment issues. Human morality is as blind and imperfect as man himself." Sympathy or desire for reciprocal benefits are only small factors in the growth of morals. Again, though "the conception of the Good is the logical foundation of every rule of action . . . the standard of conduct may be affected by causes which are not ethical in origin, though they may come to have ethical consequences. . . . For example, a magical rite may be prescribed as a duty because it is believed to be efficacious in averting a calamity to one's self, one's family, one's society, as the case may be. If the belief in magic disappears, the performance of the rite will cease to be obligatory, although there may be no change in the current conception of the duties to society, family, or self." In this connection, the author has been very successful in estimating the part in morality played by the body of tradition.

With regard to the development of ethical conceptions, we are "constantly tempted to believe that an animal is guided by clear ideas, while the evidence when all put together goes to prove

that it is moving towards an end without clearly and fully apprehending what that end is. And when we have once grasped the possibility of this pseudo-purposive action, we are tempted to generalise it, and deny intelligent purpose in all cases." So the primitive mind is guided by feelings and impulses which it cannot fully understand, and observers may be misled so far as to assert that this or that tribe is destitute of all conception of right and wrong. From the beginning man has been bound by moral law, and the author finds, throughout, "a recurrence of the common features of ordinary morality, which is not less impressive than the variations." Yet, while "ethical progress is essentially a progress in ethical conceptions, acting through tradition," the question whether, "morally considered, the human breed has in fact improved" is difficult to settle. Here the researches of Freud into the nature of the "unconscious mind" would be in point, but "Morals in Evolution" is mainly a study in morphology. As such it is invaluable.

(2) Hegel argued that the State is the realised ethical idea. It is interesting that Hegel commenced the sequence of ideas of which Treitschke was the most spectacular exponent. Prof. Ford, of Princeton, has made "a detailed survey of connections between biology and politics inferable from the doctrine of Darwinism." He concludes that "the fundamental difference between Man and other mammalia is that he is distinctly a product of social evolution." "Man," as Profs. Geddes and Thomson have observed, "did not make society; society made Man"; "the individual," says Prof. Baldwin, "is the result of refined processes of social differentiation." Prof. Ford's book seems to be a series of lectures, based on appropriate quotations in biology, psychology, and linguistics, to contradict the theory of "individual evolution" so called. The State, as Aristotle said, is prior to the individual; language and social psychoses have helped to make the individual mind. There is a well-defined series of stages in the social organic evolution; phylogenetic theory passes into political science. The evolution of the State and the evolution of the individual mind are two aspects of one process, which starts from the human genius for social life. The chief interest of this view is in the relation between man's biology and psychology, and here the advocates of what Prof. Ford styles "the Social Hypothesis" have to assume a "psychological chasm" between man and the primates. Thus, if man's peculiar development of intelligence accounts for the beginings of a social evolution superior to others, and if his peculiar intelligence is only to be explained by the action of his social evolution, there is a circular argument at the very starting-point of the hypothesis.

(3) In his preface to Miss Hughes's volume Prof. J. H. Muirhead observes that the war will pass judgment on two ideals of education, which are intimately bound up with the theory of the State and with the practice of government and citizenship. In the one there is "the disinterested development of the powers of the individual, to the end of giving him his place in a community of free and equal citizens with an outlook beyond to a world-order of like communities." In the other there is a community "narrowed down to a particular nation and state, carrying with it the regimentation of powers and the subordination of will to the end of its own particular purpose of racial predominance." Miss Hughes argues that the "root causes and the root cures of social evils are educational rather than economic," and she pleads for more of the humanist ideal in our educational system. Our elementary education has been adversely criticised; the author succeeds in pointing out its real merits and in proving many good results it has had upon our citizenship. The problem of the school is the problem of the nation, as the Greeks realised long ago. This enthusiastic teacher perhaps asks too much of the average mentality of the people, but not the least merit of her book is the wealth of practical suggestions which deserve the attention of all interested in education, since they are evidently inspired by a high idealism and based upon personal experience.

A. E. CRAWLEY.

CHEMISTRY AND THE MICROSCOPE.

Elementary Chemical Microscopy. By Prof. E. M. Chamot. Pp. xiii+410. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1915.) 12s. 6d. net.

THIS book forms a welcome addition to the very restricted literature of chemical microscopy. It affords a considerable amount of information concerning the microscope itself, and its special adaptation to the purposes of the chemist and metallurgist. It also places at the disposal of the chemist the data for performing a large number of more or less trustworthy microchemical reactions. One notices immediately, however, a singular omission, that of any reproductions of either drawings or photomicrographs of the crystals produced in these reactions as observed under the microscope. A book on microchemical analysis without any indications other than verbal of the appearances seen under the microscope is surely like the play of "Ham-

let" without the title-rôle. Considering the excellent photomicrographical apparatus now available such an omission is not easy to understand. More than twenty years ago the reviewer prepared and showed to his students in the form of lantern slides numerous photomicrographs of the crystalline products of chemical reactions. The book of Haushofer (which does not appear to be mentioned at all by Prof. Chamot), published so long ago as 1885, although faulty in many respects, contained a large number of reproductions of careful drawings of the appearances on the microslip, and the later work of Behrens was also well illustrated in a similar manner.

Another defect obvious to British readers is the very slight mention of, or even complete omission of any reference to, much of the important work achieved by British workers in this domain, especially as regards instruments. For instance, the splendid crystallographic microscopes constructed in London by Swift are ignored, although, after using almost all the Continental microscopes, the reviewer considers no instrument can compare for efficiency or elegance with the later forms of the Dick microscope as made by Swift. Such omissions, however, are not at all uncommon in the recent books and memoirs of United States authors. For example, Prof. F. E. Wright, in a recent memoir on "A New Crystal-grinding Goniometer," an instrument for preparing accurately orientated surfaces on crystals, while making considerable reference to very inferior German apparatus, merely makes a footnote reference to the refined, rigidly stable, very efficient, and much more complete instrument for this purpose constructed long ago by Messrs. Troughton and Simms for the reviewer, and with which the thousands of section-plates and prisms have been prepared for his prolonged work on the sulphates and selenates and numerous double salts. Perhaps the lessons of the war will enable our cousins in the United States to appreciate more fully the important pioneer work in science done in this country, and to be less ready to accept the much more widely advertised German work as being alone worthy of consideration.

When such defects as have been referred to are discounted, a very valuable aid to chemical microscopy will be afforded by Prof. Chamot's book. One of the most interesting chapters is one on ultra-microscopes. It is shown that the ultra-microscope renders visible particles so minute that their diameters may be only slightly greater than the half-wave-length of the light employed, on the principle of the "Tyndall effect," that which is evident in the dust scintillations (diffractions) of a beam of light passing through an orifice into a darkened room. Good illustrations and explanations are given of the Cotton and Mouton, Cardioid, and Zsigmondy ultra-microscopes, the Jentsch ultra-condenser, and the slit ultra-microscope. There is, moreover, a good chapter on the determination of index of refraction by means of the microscope, and also one on attempts at quantitative analysis by the same instrument, including an account of the Barger method of determining molecular weights by micrometric measurement.

The small amount of crystallography, about a dozen pages, is both antiquated and not always accurate; no student could possibly obtain a true idea of the subject without previous or further study. In the preface Prof. Chamot states that his book is intended for students who have passed through a course in crystallography. If there should be many such happy students in the United States they are much more fortunate than their British cousins. Indeed this book only adds one more to the many examples for the very urgent need, both in America and in this country, for the provision of efficient instruction in a subject which is now an essential one to the correct understanding of either chemistry, physics, metallurgy, or any of their many specialised ramifications.

A. E. H. Tutton.

MATHEMATICAL THEORY AND PHYSICS.

(1) *The Mathematical Analysis of Electrical and Optical Wave-Motion on the Basis of Maxwell's Equations.* By Dr. H. Bateman. Pp. vi + 159. (Cambridge: At the University Press, 1915.) Price 7s. 6d. net.

(2) *Homogeneous Linear Substitutions.* By Prof. H. Hilton. Pp. 184. (Oxford: At the Clarendon Press, 1914.) Price 12s. 6d. net.

ORIGINAL, and in fact fundamental, work in mathematics proceeds very rapidly in these days, and in so many departments, that even the expert mathematician frequently complains that it is impossible to keep pace with any but a restricted field. In these circumstances, we can well imagine the position of the unfortunate student who wishes to do mathematical work of a post-graduate nature, and even knows where his inclinations lie, but is appalled by the difficulty of discovering the present condition of any branch of the subject. There is room at present for many volumes which shall fulfil one or more of three main functions—collect together the fragments of a fundamentally important body of theory from their hiding-places in periodicals and text-books on other subjects, give the student exhaustive references to and criti-

cisms of the necessary literature, and specifically indicate the problems which are now awaiting solution. If only because they discharge these functions in two departments of mathematics which, in the opinion of the present writer, are the most difficult of approach by the student, the two volumes now under review have made a most welcome and timely appearance.

(1) The subject dealt with by Dr. Bateman is of very recent growth as such, and is of nearly equal interest to the pure mathematician and the physicist. The references to the workers in this department are sufficient to indicate this fact, and yet the author has been singularly successful in his effort to make the work intelligible to readers who lack a somewhat extended mathematical equipment. Several other branches of modern electrical theory are large enough to need a text-book of their own, such as the Principle of Relativity, and these branches, already provided for, the author does not touch in detail. In fact, the scope of the work is limited to such developments of the electro-magnetic theory as are directly concerned with the solution of the equation of wave motion—the "boundary problems" of the physicist. The theories of potential problems, the scattering and diffraction of waves by obstacles of various forms, the pressure of radiation, electrical vibrations on variously shaped bodies, are typical examples of problems which are admirably reviewed and discussed, not only from the strictly mathematical viewpoint, but with reference to the physical implications of the results. For example, such problems as the tails of comets, wireless telegraphy, and the residual blue of the sky, come within the scope of the volume, although the author is sometimes compelled by considerations of space to give only the general outlines, with the necessary references to enable the reader to pursue the subject. An excellent account of the theory of the various mathematical functions which are necessary is given when occasion arises, without, however, the existence theorems which would render the work unwieldy.

Perhaps the most interesting part of the book is at the end, where the question of possible structure in the æther is discussed. It is sufficient to say that the greater part of the work is Dr. Bateman's own, and the reader is assured of an authoritative treatment of a very fascinating problem. References are exhaustive throughout the book, which fills all the three needs specified in our first paragraph,

(2) The subject of Prof. Hilton's work has a more restricted appeal, and is still to a great extent a matter for the pure mathematician. But recently it has come into prominence in connection with electrical theory, and the appeal is widening. Prof. Hilton has in any case rendered signal service by collecting together, into a connected body of attractive theory, the branch of mathematics which has hitherto been most scattered, or only treated casually as a particular case of more general theory. He confines his treatment to those properties of substitutions which do not depend on "groups," and all such properties which are vital to the Theory of Groups, and the theories of Bilinear Forms and Invariant-Factors receive a satisfactory and connected account in this volume. The discussion of substitutions the determinant of which does not vanish is very complete, and those with a non-zero determinant are sufficiently introduced to the student. Important applications of the work are indicated, the examples are numerous, well graded, and very suitably selected, and there are very few misprints. A student who uses Prof. Hilton's book will find the subject very attractive and easy to assimilate. It should find a place in every college library.

The book is issued by the Clarendon Press, and Dr. Bateman's by the Cambridge University Press. Each volume maintains the best traditions of the series to which it belongs.

OUR BOOKSHELF.

La Science Allemande. By Prof. P. Duhem. Pp. 143. (Paris: A. Hermann et Fils, 1915.)

PROF. PIERRE DUHEM, member of the Institute, has printed four lectures which he gave to students at the University of Bordeaux. Their general aim was to deliver the minds of his hearers from subservience to German thought, and they certainly make for fresh air. The first deals with mathematics and philosophy, and its conclusion is that an excessive fondness for deductive method and a contempt for common sense have made intellectual Germany like the house of Chrysale, whence reasoning drove forth reason. Hegel's axiom as to the identity of contradictories is compared to that of Nicolas of Cues, often called the *cardinalis teutonicus*, that the maximum is always identical with the minimum. But this is surely playing to the gallery. The second lecture is devoted to the experimental sciences, and includes an interesting sketch of Pasteur's trial and error methods, a denunciation of Haeckel, and an assurance that Fabre's fine work has left us with scarcely more than the débris of the Darwinian theory. The exaggeration and misunderstanding involved in the last statement show us that the illustrious author has his obfuscating prejudices like the rest of us.

The best part of this lecture is its illustration of "*l'esprit de finesse*" in French science. The third lecture is on the historical sciences, and is full of righteous anger. It illustrates the

writing of history under the conception of "Deutschland über alles." And not only the writing of history, for it seems that German editions of Cæsar's Commentaries have been subjected to surgical treatment to make them conformable with the axiom. It is not to be supposed that Prof. Duhem has not respect for giants like Leibniz and Gauss; indeed, in the fourth lecture and the appendix, he gives (more philosophically than in the rest of the book) careful appreciation of the geometrical spirit which is at once the strength and the weakness of German science. Of this geometrical spirit English science is all but destitute; its strength is in intuition. The characteristic French qualities are order and clearness, and *l'esprit de finesse*; and each has much to learn from the others.

Mineral Resources of Minas Geraes (Brazil). By A. F. Calvert. Pp. xvi+100+127 plates. (London: E. and F. N. Spon, Ltd.; New York: Spon and Chamberlain, 1915.) Price 6*s*. net.

THIS little volume contains a eulogy of the mineral wealth of the famous State of Minas Geraes, the importance and value of which have long been well known to all who have studied, however superficially, the distribution of the world's mineral resources. The author appears to have searched diligently all available records of Brazilian mining and has evidently read widely and extensively; it is only a pity that he did not supplement his want of knowledge of technical matters by getting some competent mining engineer to revise his proof sheets. This would have saved him from repeating such a foolish criticism as that of Sir Richard Burton upon the shortcomings of the Brazilian miner:—"The Davy and the Geordie were equally unknown to him," the mines referred to being gold mines (!); it would have prevented him from persistently writing "phosphorous" instead of "phosphorus"; it would have most certainly corrected his version of the reports of Baron von Eschwege, from which it seems that the author is unaware that the German equivalent of "blast furnace" is "Hochofen," and that "high furnace" is a phrase that conveys no meaning to the British smelter.

Perhaps the most interesting sentence in the book is one in the preface, where the author summarises the causes that have led to the poor results obtained in Brazil, as a rule, from such great natural resources; he enumerates them as follows:—"Liberation of the slave workers, bad legislation and exorbitant taxation, lack of railway communication, political unrest and financial instability, and the incompetence and dishonesty that have attended the exploitation of the mines and the management of the companies that have been formed to work them," and goes on to point out that in his opinion these drawbacks are being steadily removed. Most British capitalists who have had experience of extensive business operations in Brazil would be disposed to add several very significant items to the above list, not the least important of which would be the rapid fluctuations in the rate of exchange.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Magnetic Measurements.

WITH reference to the very kindly review in NATURE of July 29 of "Electrical Instruments in Theory and Practice," by Mr. U. A. Oschwald and myself, your reviewer takes exception to the suggestion on p. 32 and elsewhere that "in view of its great simplicity the method of testing by the magnetometer ought to be more used than at present."

The reason urged for the rejection of magnetometer methods is that disturbances from neighbouring current-carrying conductors would render it useless, and presumably ballistic, or other methods should be used instead.

I wish to point out on behalf of Mr. Oschwald and myself that we did not suggest the adoption of magnetometer methods in any haphazard way. Both of us have had considerable experience of magnetic work, and the suggestion was made for the following reasons

(1) In ballistic work, if a Thomson moving needle galvanometer is used, as is frequently the case, the same sources of error are present.

(2) No ballistic galvanometer can be calibrated very accurately at present. The values of the constant as determined by Messrs. Hadfield and Hopkinson (Journal Inst. Electrical Engineers, vol. xliv., p. 270) by condenser, standard field, and steady deflection, differ amongst themselves by about 1 per cent.; and there are generally other sources of error in magnetic work.

Now, when electric light wires are laid in a building, the flow and return wires are generally close together in casing, or iron tubing, so that the effect with any reasonable precautions is *less* than 1 per cent. Hence the method is practically equal to the ballistic one, so far as accuracy is concerned

Again, for rapidly *comparing* specimens of iron by the zero method, the objection vanishes, and there is nothing to approach the magnetometer for this purpose.

In my opinion, the ballistic galvanometer is a considerably overrated instrument for this purpose, due possibly to the fact that errors in its constant are conveniently forgotten in the course of research.

Apart altogether from accuracy, there is the outstanding feature of the simple magnetometer, viz. that it measures directly the forces we are dealing with, whereas the ballistic method depends on measuring another quantity altogether. I think I am not wrong in hoping that the magnetometer will be partially restored to its ancient position as the premier magnetic testing instrument.

W. H. F. MURDOCH.

September 3.

WITH reference to Mr. Murdoch's letter on the magnetometer method of testing iron, I described it as an admirable method under suitable conditions. I tried the method about three years ago in my laboratory, which is close to a track return tramway line, and had great trouble with it owing to zero fluctuations. The same difficulty has been found in other laboratories close by, where instruments with very weak magnetic control have been set up. I did not take exception to the suggestion that the

magnetometer method might be used more than it is at present *under suitable conditions*; I wished to direct attention to its practical limitations.

THE REVIEWER.

Nodules on the Intermediate Bladderwort.

I RECENTLY had an opportunity of examining living specimens of a very rare British plant, the intermediate bladderwort (*Utricularia intermedia*), and found that the leaf-bearing stems ended in a solitary terminal knob or nodule, the largest being the size of a small peppercorn. What are these knobs? Are they autumn plant-buds that will ultimately grow into plants? This seems to me a possible solution; but (my edition of) Bentham does not mention that the plant propagates itself in this way, nor are the knobs figured in the companion volume of illustrations by Fitch and Smith.

HAROLD EVANS.

Llanishen, Cardiff, September 17.

NOTES ON STELLAR CLASSIFICATION. III.

IN the year 1890 a photographic study of the spectra of stars was commenced by me at the Solar Physics Observatory at Kensington. The object of the investigation was not so much to make a spectroscopic survey of the stars generally as to examine with considerable dispersion the spectra of the brighter individual stars. Up to the end of the year 1900 there had been accumulated a large number of spectra, a catalogue of which was published in the year 1902. This contained 470 of the brighter stars.

In this catalogue the stars were classified according to their spectra after a minute inquiry of the lines due to each of the chemical "elements" involved.

The spectra of 105 of these 470 stars were photographed by Dr. F. McClean at the Cape Observatory.

Details of this classification were given in the publication above mentioned, but a brief summary may here be given. The stars were arranged in two main groups, one in which the stars were getting hotter ("hotting"), and the other in which they were cooling. The differentiation of these two groups was based, not only on their chemistry, but on other differences observed on the two arms of a "temperature curve."

On the temperature curve the stars increasing their temperature were located on the left-hand branch or ascending arm of the curve, and the cooling stars on the right or descending arm. The stars of the highest temperature were located at the apex of the curve.

The two main divisions of stars, *i.e.* those getting hotter and those getting colder, were each classified according to their chemistry and placed at their respective levels on each side of the temperature curve. At equal levels on each arm the stars were considered to be of the same temperature, each group being designated by a name derived generally from that of the "type star" which had been selected to represent that group.

Further experience with this method of stellar classification led to the detection of criteria which have suggested the interpolation of additional groups, and those have now been embodied in the general scheme as given below representing the classification in use at present, and to it has been added the Harvard scheme of classification of the type stars employed by me.

Harvard Classification			Harvard Classification
Oa Pec. Od	Argonian		
Oe5	Alnitamian	IV	
B		III	
B		II	
B		I	
B2	Crucian	Achernian	B5
B3	Taurian	Algolian	B8
B8 Pec.	Rigelian	Markabian	A
A2 Pec.	Cygnian	Sirian I	A
	—	Sirian II	A5
F8 Pec.	Polarian	Procyonian I	F5
G	Aldebarian II	Procyonian II	G
K5	Aldebarian I	Arcturian	K
Ma	Antárian	Piscian	N

The main routine work at the Hill Observatory at Sidmouth, since the McClean telescope was brought into use in September, 1913, has been a spectroscopic survey of all stars down to the fifth magnitude other than those published in the above-mentioned catalogue; incidentally the spectra of a number of stars fainter than magnitude five have also been photographed.

This programme of work is especially fitting for this observatory, because the same instrument is in use which Dr. Frank McClean employed in his spectroscopic survey of stars equal to or brighter than magnitude 3·5, the telescope having been presented to the observatory by his son, Frank Kennedy McClean.

The McClean instrument consists of an equatorially mounted twin-telescope with apertures of 12 and 10 inches, and focal lengths of 134 and 150 inches respectively. The former is fitted with an objective prism of 12 inches aperture and 20° angle, and is mounted in a metal frame in such a way that it may be moved clear of the objective. In the focal plane is placed a camera fitted with a swing back by Messrs. Hilger. This carries a plate-holder for plates $6\frac{1}{2} \times 4\frac{3}{4}$, but an adapter has been inserted to carry plates $4\frac{1}{4} \times 3\frac{1}{4}$ which are in use. The dispersion on the photographic plate between K and $H\beta$ is equal to 28 mm. or 927 Ångström units.

The telescope, built by Sir Howard Grubb, of Dublin, is driven by means of falling weights, and is fitted with electric control movements regulated by an electric pendulum. The governor is of the heavy ring pattern, and is adjusted by means of a cam. The declination circle is electrically illuminated, and viewed with the aid of one of two reading telescopes from the camera end. In addition to two finders of 4-inch and 2-inch aperture fitted to the 10-inch tube, a 3-inch finder deviated to the angle of the prism has been specially attached to the tube of the 12-inch; this serves the purpose of observing the amount of

clock rate and for "following" in the case of photographing the spectrum of a comet.

In order to obtain a serviceable width and the necessary density to the spectra, a rate of acceleration or retardation is given to the driving clock. This rate depends on the magnitude of the star in question, its type of spectrum, and its declination. The adjustment for rate is accomplished by regulating the speed of the governor ring by means of the cam mentioned above, the indicator being set to readings which have been derived from previous photographs.

The McClean telescope is mounted on three concrete pillars in a building with a circular concrete-block wall, internal diameter of 18 ft., on which is a hemispherical dome made of wood and covered with rubberoid. The wall is double—that is, has an air space in order to prevent rapid changes of temperature of the air in the dome. The dome rests on iron wheels running on a circular rail fixed to the upper part of the wall, and is easily revolved by hand by means of an endless rope round a grooved pulley fixed to the axis of one of the wheels. The shutters, also operated by hand, are made in two sections and run on rails at their upper and lower extremities; when open, a clear view of the zenith is obtained.

All the electric connections for the telescope and lighting purposes and for the driving-clock wire are led in a trough into an annexe in which are placed the electric pendulum, small accumulators, dark room, etc.

The building is situated on the top of Salcombe Hill to the east of Sidmouth; it is 580 ft. above sea-level, and commands an uninterrupted view of the horizon in every direction.

Since the instrument was first brought into use in September, 1913, the site has been found to have all the excellent observing conditions that were anticipated.

Smoke, mist, artificial-light glare are conspicuous by their absence, and on only one occasion has high wind in a clear sky prevented observation. The hill-top is often clear when the adjacent valley is filled with mist or cloud. Cloud on the top is rare.

The purity of the sky on almost all occasions when free from clouds is extremely advantageous for photographic observations. At South Kensington such clear, dark skies were extremely rare, and then only one or two hours in the early morning were at all comparable with the conditions here. The excellence of the atmospheric conditions is well shown by the extension of the spectra into the ultra-violet. A spectrogram of α Cygni taken with the 9-in. Henry prismatic camera shows the hydrogen series down to H_ω (λ 3667·8), *i.e.* twenty-three hydrogen lines on the one plate. The most refrangible hydrogen line recorded in the South Kensington reduction of the spectrum of α Cygni was H_θ (λ 3798). It may also be mentioned that the southern stars α Columbæ (dec. $-34°\ 8'$) and λ Scorpionis (dec. $-37°\ 2'$) have been seen with the naked eye. The steadiness of the image is normally greater than at South Kensington, and long exposures on faint stars give spectra showing definition of a very satisfactory character.

The working list prepared for use with the 12-in. McClean instrument contains all the stars of the Harvard revised photometry of magnitudes fainter than 4·0 and brighter than 5·0 to the north of dec. $-15°$ which were not included in the catalogue of 470 brighter stars compiled at South Kensington. For these stars exposures of twenty minutes to one hour, according to magnitude and type, are usually amply sufficient to yield spectrograms of sufficient width and density to exhibit enough detail for the purpose of classification. Neighbouring stars fainter even than 6·0 magnitude are sometimes satisfactorily recorded.

A catalogue of the stars the spectra of which have been photographed and classified since 1913 at the Hill Observatory has been prepared; it contains 354 stars. The designations, positions for 1900, magnitudes, and Harvard classification have been taken from the Revised Harvard Catalogue (Annals of the Astronomical Observatory of Harvard College, vol. iv.). In the last column of the table is given the equivalent Kensington classification. The small letters *h*, *c*, and *a* indicate whether the star is increasing its temperature (hotting) (*h*), decreasing its temperature (cooling) (*c*), or at the apex (*a*) of the temperature curve or about the condition of being most hot. The letter (*p*) denotes that there is some peculiarity about the spectrum.

These small letters will save references to the groups in my classification in the case of those inquirers chiefly interested in temperatures. They also show that the Harvard classification includes both classes of stars under the same designation in the other cases.

Before the war Lieut. Lockyer, R.N.V.R., and Mr. Johnson and Mr. Goodson were the assistants engaged in photographing and classifying the spectra. Since Lieut. Lockyer and Mr. Johnson took up their military duties, their work has been carried on by Mr. Goodson.

NORMAN LOCKYER.

THE ATTACKS OF BIRDS UPON FRUIT.

UNDER the heading of "The Ravages of Birds" a correspondence has arisen in the *Times* which is apt to mislead both the general public and fruit-growers on a subject already overburdened with misrepresentation and error.

It is suggested by one correspondent that there are two simple methods for preventing the attacks of birds upon fruit, viz., (i) provision of drinking water, (ii) provision of food to entice the birds away from the fruit. That there may be a scarcity of water in some districts is quite possible, but at the time when the missel thrush, blackbird, blackcap, bullfinch, etc., attack fruit there is an abundance of animal food in the form of insect larvæ, insects, worms, slugs, snails, etc., in addition to wild fruits and seeds. Further, if a few of these fruit-eating birds are shot, and the

stomach contents examined, it is surprising how little fruit-pulp is found. Again, if blackbirds are kept in confinement and fed on similar ripe fruit very little is consumed.

Careful observation and experiment have shown that in most cases where ripe fruit is attacked it is not due to a scarcity of food, and that very much more fruit is damaged than eaten. In different parts of the United States it has been found that the provision in orchards of water has considerably lessened the damage by birds to the fruit.

Mr. G. F. Burgess, another correspondent, asks, "If the birds need water, why provide food? If it is food they want, why provide water? It is quite possible," he continues, "that the birds acquired the 'fruit habit' in times of drought, but the habit is now so well established that the damage goes on in wet and dry seasons alike." This brings us much nearer the actual truth. A supply of water may keep young birds away from the fruit in times of drought, but once a bird acquires the fruit-eating habit, experience shows that nothing will change it.

This change of habit in the nature of the food opens a big question, and one around which much controversial matter ranges, but where cases have been subjected to careful investigation by competent workers one striking fact has been brought out, viz., that the particular species of bird or birds had been allowed to increase unduly, and is now too plentiful. This has been proved in the case of the cereal-feeding habit of the rook,[1] and the fruit-eating habit of the blackbird and missel thrush.

It seems surprising that, in a country where the question of producing the maximum amount of home-grown food is one of vital importance, so many economic problems related thereto have been almost entirely neglected. We are offering protection to certain injurious wild birds and permitting other beneficial species to be wantonly destroyed, with the result that food to the value of tens of thousands of pounds sterling is annually destroyed. That the same thing is taking place in connection with our fisheries there is good reason to believe.

In other countries the State has made provision for systematic and continued investigation on the subject, much to its material benefit, but as a writer has recently very pertinently stated, "In the matter of economic ornithology we in England are disgracefully behind the times; the Board of Agriculture seemingly prefers to leave this matter to private enterprise, or to deal with the matter in such a perfunctory manner as to be positively ridiculous, making us the laughing-stock of the nations."[2] In the past the want of financial means has been the excuse, but the present apathy can scarcely be due to that cause, seeing the manner in which huge sums are being used out of the Development Grant for far less important purposes.

WALTER E. COLLINGE.

1 "The Food of Some British Wild Birds." (London, 1913.)
2 *Ann. and Mag. Nat. Hist.*, 1908 (s. 8), vol. ii., p. 132.

NOTES.

AMONG those who were on board the *Royal Edward* when she was torpedoed and sunk in the Ægean Sea was Capt. Charles Bertram Marshall. When last seen he was standing on the deck giving orders to his men to keep cool; and he seems to have died as he had lived, a brave, generous, and unselfish man. Although Capt. Marshall had no intention of devoting himself to purely scientific pursuits, he belonged to that too rare class of medical men who, before embarking upon the practice of their profession, endeavour to obtain a thorough all-round training in the ancillary sciences and experience in original research. In addition to the customary series of hospital appointments, Dr. Marshall held a demonstratorship in anatomy in Manchester University, and carried out a successful investigation in reference to the movements of the stomach and the chemistry of the digestive processes, for which he received the M.D. degree with commendation. He was a man of exceptional ability and charm of character, and he gave promise of accomplishing much in the advancement of the science of medicine.

WE regret to see the announcement that Lieut. J. A. Dixon was killed at the Dardanelles on August 9. After a first season's work in Nubia, he took part in the expeditions sent to Abydos in Upper Egypt by the Egypt Exploration Fund in the winters 1909–10 and 1910–11, in the capacity of draughtsman and assistant excavator. The illustrations of the volumes dealing with those expeditions are a sufficient testimony to the amount and quality of his work. His ambition, however, was to make a name for himself in the field of copying in water colours the scenes which adorn the rock tombs of Thebes, and his first efforts in this direction had met with considerable success. In the desert camp, where the qualities of a man are tried to the utmost, he was a keen worker and a bright and frank companion, generous to the last degree. He loved Egypt and everything in it, from the luxury of a Cairo hotel to the discomfort of the excavator's camp. His treatment of natives was ideal: sympathetic, just and friendly, and yet with that background of firmness which too many Europeans lack, but which is, in truth, the only passport to the respect and admiration of the Arab. Since 1912 he had been connected with the expeditions of Mr. Wellcome in the Sudan, but there is little doubt that his heart was in Egypt proper, and that, had he lived, he would have contrived to return to his painting among the Theban tombs.

MR. CLAUDE GRAHAME-WHITE and Mr. Harry Harper contribute to the *Fortnightly Review* for September an interesting account of "Zeppelin Airships: their Record in the War." It is refreshing to find an article on aircraft, especially Zeppelin airships, which is not full of that nonsense which the present conflict has inspired in overflowing measure. A highly-complex technical problem such as the airship presents is not readily made clear to the lay mind, and the authors of this article give only slight space to a discussion of technical questions of construction,

confining themselves to a consideration chiefly of the Zeppelin airship as a weapon of war. This aspect, while fascinating to the layman, is to the average technical mind much the least attractive avenue of speculation and inquiry, seeing that difficulties which can be comfortably overcome by a peace-airship are quite insuperable in one for use in offensive operations. It is easy to conceive airships in the future having sufficient strength to withstand all ordinary weather, but it is frankly impossible to conceive an airship that will stand any chance of surviving the anti-aircraft gunnery of the immediate future, provided it can be seen by the gunner. For offensive operations of value, the airship cannot avoid being in sight of the ground, and consequently it will be unable to undertake such operations. All war, however, does not consist of fighting, and there is plenty of scope for the excellent qualities of lighter-than-air aircraft in reconnaissance and so forth. It is a pity that so much ill-informed matter has been written about Zeppelins as aerial "Dreadnoughts"—in point of fact, there is very little else they can do when attacked but run away. The authors of this article are to be congratulated on the sane aspect of the case they have presented.

DURING the recent meeting of the British Association, the members were invited by the Manchester Literary and Philosophical Society to visit its house in George Street, Manchester. Particular interest is attached to this house, since it was for many years the scene of the labours of John Dalton, and contains a collection of his apparatus, lecture diagrams, notebooks, and manuscripts. This collection, along with other treasures belonging to the society, was set out for exhibition, and was described to the visitors by Prof. W. W. Haldane Gee. The apparatus, which is in a remarkably good state of preservation, includes a valuable collection of instruments used by Dalton in his researches and in his lectures on chemistry, heat, light, sound, electricity, mechanics, meteorology, and astronomy. The diagrams, many of which refer to the atomic theory, are those used by Dalton to illustrate his lectures. They are described by Prof. W. W. Haldane Gee, Dr. H. F. Coward, and Dr. Arthur Harden in a "Memoir" of the society. The notebooks, manuscripts, etc., which are also described in the "Memoir," show the nature and scope of Dalton's lectures, and give some interesting information about his expenses. The Manchester Literary and Philosophical Society is one of the oldest scientific institutions in the world, and has held its meetings in the house in George Street for nearly 120 years. The list of its past presidents includes such illustrious names as James Prescott Joule, John Dalton, Sir William Fairbairn, and Sir Henry Roscoe. The society possesses a very valuable library, which includes a collection of the publications of almost all the important scientific societies from their foundation.

A TABLET was unveiled on September 18 in Cheltenham College Chapel, and a life-size portrait by Mr. Hugh Riviere in the College Library, to the memory of Dr. E. A. Wilson, who perished with Captain Scott in the Antarctic. The late Dr. Wilson was educated at Cheltenham College.

AT the sale by auction of the Amesbury Abbey estate on September 21, the historic monument of Stonehenge was purchased for 6600*l.* by a local landowner, Mr. C. H. E. Chubb, of Bemerton Lodge, Salisbury. The estate came into the market in consequence of the deaths of Sir Edmund Antrobus and of his only son, who was killed in action last October. As Stonehenge is under the protection of the Ancient Monuments Act, no steps can be taken by the owner to alter or remove any parts of this remarkable relic of antiquity.

ACCORDING to the *Morning Post* correspondent at Christiania, a telegram from Archangel to the Foreign Office there states that the *Eclipse* Expedition, under Commander Sverdrup, has returned, and that all on board are safe Commander Sverdrup left Christiania on July 15, 1914, at the request of the Russian Government, with the object of seeking for traces of the Russian expeditions under Brusiloff and Rusanoff, which had been lost in the Polar regions. He wintered in the western portion of the Taimyr Peninsula, and engaged in exploration work during the succeeding summer, but found no traces of the missing Russians.

SIR FREDERICK DONALDSON, Chief Superintendent of Ordnance Factories, has been appointed to act for the time being as technical adviser to the Ministry of Munitions. In the meantime, arrangements have been made for Mr. V. L. Raven, chief mechanical engineer of the North-Eastern Railway, whose services have been temporarily placed at the disposal of the Minister of Munitions by the board of directors, to perform the duties of acting chief superintendent of the Royal Ordnance Factories, Woolwich.

THE Minister of Munitions of War, with the concurrence of the Home Secretary, has appointed a committee to consider and advise on questions of industrial fatigue, hours of labour, and other matters affecting the personal health and physical efficiency of workers in munition factories and workshops. The committee is constituted as follows:—Sir George Newman (chairman); Sir Thomas Barlow, Bt., K.C.V.O., F.R.S.; G. Bellhouse; Prof. A. E. Boycott, F.R.S.; J. R. Clynes, M.P.; E. L. Collis; Dr. W. M. Fletcher, F.R.S.; Prof. Leonard E. Hill, F.R.S.; Samuel Osborn, J.P., Sheffield; Miss R. E. Squire, and Mrs. H. J. Tennant. Mr. E. H. Pelham has been appointed secretary to the committee; and all communications should be addressed to him at the offices of the Board of Education, Whitehall, S.W.

THE nature and limitations of portable fire-extinguishers were dealt with in articles in NATURE of June 3 and July 22. Sir Edward Henry, the Commissioner of Metropolitan Police, has now repeated a warning issued on June 28 that chemical liquid fire extinguishers should not be purchased without a written guarantee that they comply with the specification of the Board of Trade, Office of Works, Metropolitan Police, or some approved fire prevention

committee. Many dry powder fire extinguishers are much advertised. The Commissioner warns the public, as the result of experiments made at his instance, by a competent committee of experts, that no reliance can be placed upon such appliances for effectively controlling fires such as are likely to be caused by bombs—explosive or incendiary. The Commissioner is advised as the result of these experiments that the provision, and prompt and intelligent use, of water or sand or of both in dealing with such outbreaks of fire is the best, simplest, and most economical safeguard.

THE United States National Museum, Washington, has recently obtained the greater part of a fine skeleton of Mastodon from a swampy deposit near Winamac, Indiana. The bones are in a good state of preservation, and when prepared will be mounted for exhibition.

THE eighth number of the *Boletin* of the Sociedad Physis of Buenos Aires, just received, completes the first volume of this publication. The society was founded in 1912 for the promotion and diffusion of natural science in the Argentine Republic, and has met with considerable success. All the published papers record the results of original research, and each part of the journal concludes with a useful series of reviews and notices of writings dealing with the geology, botany, zoology, and anthropology of South America.

DR. J. W. FEWKES, of the U.S. Bureau of Ethnology, has started to continue his exploration of the remarkable ruins in Mesa Verde National Park in south-west Colorado, which are believed to be the work of the ancestors of the modern Pueblo Indians. One of these constructions, known as Spruce Tree House, resembles a gigantic hotel built in a cave, the floor of which is about 50 ft. above the bottom of the canyon, while the roof is 80 ft. high. In some places the rooms occupied three stories, and the building may have accommodated 350 persons. Cliff Palace is nearly three times the size of Spruce Tree House, and, like it, stands in a cave to which access is gained by steps cut in the rock and by ladders. An important part of this structure is a ceremonial chamber entered from a subterranean passage. Here it is believed that the tribal ceremonies were performed. These structures, when fully excavated, will throw much light on the social life, religious and secular rites of this remarkable people.

WE have received a copy of the Madras Agricultural Calendar for the year 1915–16, issued by the Madras Agricultural Department, which contains a series of useful articles on green manuring, cotton and its cultivation, on various veterinary subjects, and on native implements and subjects of value to the small proprietor. The calendar portion gives information about cattle fairs and other matters of native interest, and, by way of introduction, the purpose of the Agricultural Department is fully explained.

THE first number of the Journal of the Botanical Society of South Africa has recently been published under the editorship of Prof. H. H. W. Pearson, hon. director of the National Botanic Gardens, Kirstenbosch. It includes a short notice of the late Lord de Villiers, the first president of the society, to whose interest and influence the establishment of the gardens and the founding of the society was so largely due. An interesting account of former public and private acclimatisation and botanic gardens at the Cape, with an outline of the establishment in 1913 of the National Garden at Kirstenbosch, is also given. It is a matter of regret that this important enterprise seems likely to suffer financially owing to the war, just when funds are so essential for furthering the initial stages of its development. It is to be hoped that the Botanical Society, to the assistance of which the new National Garden owes so much, will continue to bear its share in the responsibility of developing the Garden as generously as in the past, and will be able to enlist many new members to help on the work.

THE Transactions of the Royal Scottish Arboricultural Society, vol. xxix., part ii. (July, 1915), contain several articles dealing with larch, the most interesting being an account of the first-generation hybrids between the Japanese and the European species, which are making astonishingly rapid growth on two estates in Perthshire, where they originated a few years ago. A new species, *Larix olgensis*, from eastern Asia, is described and figured; but it is not considered likely to be of any value for economic planting. Mr. Marshall, who has extensive plantations of larch in the Lake district, gives the results of experiments, which show that the wood of the Japanese larch is considerably inferior in strength to that of the European species, at any rate when young and of a size only big enough for pitprops. The Transactions contain useful notes on various insect and fungus pests. It is satisfactory to learn that new regulations of the Postmaster-General facilitate the purchase of home-grown Scots pine for use as telegraph poles.

THE number of species of Ficus at present known from tropical Africa is 173, and the genus has recently been revised for the "Flora of Tropical Africa" by Mr. Hutchinson. Descriptions of the new species, illustrated in many cases by useful text figures, are given in *Kew Bulletin* No. 7, 1915. Our knowledge of the genus has been increased mainly owing to the collections made by Dr. J. Mildbraed, and to the extensive material sent to Brussels from the Belgian Congo. The genus is broken up into five subgenera; four of these have the bracts of the ostiole of the receptacle spread horizontally across the mouth, so that some of them are visible from the outside; but in the fifth subgenus, Bibracteatæ, containing 73 species, the ostiole from outside looks like a single pore-like slit, as all the bracts are abruptly reflexed and point vertically downwards into the receptacle. The present paper deals mainly with species belonging to this subgenus.

"THE Trees and Shrubs of the Pacific Coast" is the title of an interesting paper by Mr. F. R. S. Balfour, printed in the Journal of the Royal Horticultural Society, vol. xli., part i., August, 1915, which

was delivered as a lecture before the society in April of this year. The paper is illustrated by a number of excellent reproductions of the trees and shrubs mentioned in their native habitats from Vancouver to California. The region near Mount Rainier, discovered by Vancouver in 1792, is the home of many fine conifers, notably *Abies nobilis*, *Thuya gigantea*, Douglas firs, etc., and a number of interesting shrubs, seeds of which were collected by Mr. Balfour. The Siskiyou Mountains, on the borders of S. Oregon and N. California, were also visited in order to see that rare and interesting conifer, *Picea breweriana*, the weeping spruce, of which some excellent photographs are reproduced. Possibly not more than 5000 trees of this species exist in the wild state, but it has now been introduced to Britain, and the young trees are thriving well. The drooping branchlets, some 6–8 ft. long, hang down like those of the weeping willow. The last region described in the paper is the Monterey district of California, the home of those well-known and useful conifers *Pinus insignis* and *Cupressus macrocarpa*. The latter is illustrated by photographs of picturesque old specimens. These trees, the native habitat of which is now a very restricted area, were long ago introduced to Europe, Chile, New Zealand, and the Cape, where they are thriving as in their native country.

Lignum nephriticum, the wood which, infused with water, yields a yellow solution possessing a remarkable blue fluorescence, has been an object of interest ever since it was first brought to Europe from Mexico, soon after the discovery of America. Robert Boyle made a systematic study of the solution in 1663, which may be regarded as the first serious investigation of the phenomenon of fluorescence, but considerable doubt has existed as to the exact scientific identity of the tree yielding the wood. The most recent contribution to the history of *Lignum nephriticum* is published in the Journal of the Washington Academy of Sciences (vol. v., No. 14, August 19, 1915) by Mr. W. E. Safford. He gives the name *Eysenhardtia polystachya* (Ortega), Sargent, to the tree, and states that its botanical identity has remained uncertain until the present time. This statement, however, is scarcely correct, since the tree was referred to the genus Viborquia by Ortega, a name superseded by the later name of Eysenhardtia of Humboldt, Bonpland, and Kunth. These authors correctly named the plant *E. amorphoides* in 1823, and Mr. Safford, following Sargent, merely restores Ortega's old specific name, *Viborquia polystachya*, making *Eysenhardtia amorphoides* a synonym of *E. polystachya*. The story of *Lignum nephriticum*, with an account of its remarkable properties and its synonymy, was set out at some length in the *Kew Bulletin*, 1909, pp. 293–305, by Dr. Stapf, and Mr. Safford adds very little to the account there given. His paper is of value, however, because he reproduces Ortega's original illustration of *Viborquia polystachya* and also a photograph of specimens recently collected at Tamaulipas, Mexico. It was owing to its supposed diuretic properties that the wood of this leguminous tree received the name *Lignum nephriticum*.

We learn with regret that a heavy gale which passed over the island of Dominica caused a considerable amount of damage to the Botanic Garden. About 100 trees, some of large size, were uprooted, and many others are reported to have had their tops blown off or to have been seriously damaged by the loss of branches. Unfortunately, a number of species of rare trees represented in the Garden by only a single specimen have been destroyed. The clearing of the devastated area will be a work of many weeks, and at least a generation must elapse before the Dominica Gardens can be restored to their former interesting and beautiful condition. Some of the lime estates in the island were also badly damaged, not only owing to the loss of crop, but also by the uprooting of a considerable number of trees.

In Bulletin No. 47, issued by the Agricultural Research Institute, Pusa, Mr. Peter Abel describes a tour of the sugar factories in the Bihar district of northern India, made at the invitation of the Indian Government, with the object of advising on the machinery in use and the general management of the plants. Judged by the standard of the West Indies and America, these Indian factories are small, and run on such primitive lines that many of the labour-saving devices generally used in the west are not applicable. The approaches and exits were in most cases badly arranged, resulting in blocks and confusion of the bullock carts delivering cane. As the feeding of the mills is done entirely by hand a great deal of labour could be avoided by the use of suitable derricks for handling the cane, and at the same time give a more regular feed to the mills. The methods of clarification appeared to be capable of considerable improvement, many of the appliances being defective or badly situated for inspection and cleaning. In most of the factories the evaporators and vacuum pans were adequate, but in only two were the crystallisers sufficient in number to ensure the maximum reduction of the sucrose in the molasses. Since the quality of sugar depends to a great extent upon clarification, the inefficiency of this section of the plants is responsible for the inferiority of the average product. One small factory, however, possessing an adequate clarifying and crystallising plant, was producing two sugars of excellent quality. Although the Indian factories do not at present obtain a satisfactory extraction, a few modifications and additions would enable them to obtain results very little behind those of the best works in Java.

The Carnegie Institution of Washington has just published Prof. E. C. Case's fifth contribution to our knowledge of the vertebrate fauna of the Permo-Carboniferous red beds of North America (Publication No. 207). More than half of the work is an exhaustive technical description of the geological formations themselves in all known regions, with numerous quotations from the writings of other authors. The second part is more general, and includes a valuable summary of the results of Prof. Case's own researches. The vertebrate fauna is one of estuaries, swamps, alluvial plains, and open woodlands. Among the fishes, even the sharks have a fresh-water appearance.

All the amphibians are of the usual Labyrinthodont pattern, with a carnivorous dentition. Among the reptiles the teeth are more varied, but hitherto no form has been discovered which can be regarded as purely or even largely herbivorous. Some species must have been powerful carnivores, others may have eaten plants mingled with a main diet of hard-shelled molluscs. In outward shape, according to Prof. Case's numerous restorations, there is monotonous sameness, both among amphibians and reptiles—animals with large head, short neck, ungainly trunk, and weak limbs. The only notable feature is the well-known dorsal crest of Dimetrodon and its allies, produced by the elongation of the neural spines of the backbone. During life, of course, more variety may have been imparted to the different forms by coloration and epidermal structures. Prof. Case concludes that although the earliest of the North American Permo-Carboniferous reptiles are closely related to those found in South Africa, the evolution of the group was different in the two regions. In North America all specialisations seem to have been in the direction of higher reptiles, while in South Africa specialisation was clearly in the direction of mammalia.

THE fifty-third annual report of the Government cinchona plantations and factory in Bengal for the year 1914–15 is a remarkably interesting document, and affords striking evidence of the valuable work unobtrusively carried on by the distinguished botanists who have held the post of superintendent of cinchona cultivation in Bengal. Between 1887 and 1892 enough bark was produced in the plantation at Mungpoo to meet the annual demand, never exceeding 4000 lb., for quinine. By 1905 the demand had risen to 15,000 lb., but the annual yield from plantation bark never reached 9000 lb. of quinine. A new plantation was started at Munsong, the old one improved, the factories enlarged, and a quinologist appointed, with the result that now the annual output of quinine has increased to as much as 50,000 lb. Not only has the quality of the trees planted been greatly improved and the area under cultivation enlarged, but the methods of extraction now employed have raised the average quinine percentage from 2·5 to 4·5. Since 1905 the annual possible harvest has increased from about 300,000 lb. of 2·5 per cent. bark to 1,000,000 lb. of 4·5 per cent. bark, a quantity assured for many years to come; the possible annual output of the factory has increased from 14,000 lb. to more than 50,000 lb. of quinine, its extraction efficiency has been raised from not more than 75 per cent. to 95 per cent. of the possible, while the manufacturing cost of quinine has been reduced from Rs. 9 to a little more than Rs. 5 per lb. Moreover, the quinine reserve has risen from less than 3500 lb. to more than 163,000 lb. When it is remembered that cinchona takes ten years to arrive at maturity, this record of ten years' work must be regarded as a remarkable achievement. The work of reconstruction initiated by Sir David Prain has been most ably carried on by Major Gage, his successor in office, who records his indebtedness to Mr. Shaw, the Government quinologist, and to the managers of the two plantations, Mr. H. F. Green and Mr. P. T. Russell, through whose keen interest and cordial co-operation the success of the undertaking has been rendered possible.

IT has long been suspected that the mutarotation phenomena observed in freshly-prepared solutions of many sugars might be due, not to a direct isomeric change, but to changes involving the formation of one or more intermediate products. Direct evidence in favour of this view is given in a paper by Prof. Irvine and Miss Steele on "The Mechanism of Mutarotation in Aqueous Solution," which appears in the August issue of the Chemical Society's Journal. The curves showing the changes of conductivity and of rotatory power in freshly-prepared aqueous solutions of tetramethylglucose are of the usual simple form; but when the sugar is dissolved in aqueous boric acid the conductivity passes through a maximum at the end of about two hours, whilst the rotatory power shows a well-marked arrest at about the same time. These observations indicate the formation of an intermediate product capable of combining with boric acid. The authors consider that this product is an oxonium hydrate. The conductivity curve gives some indication, however, that the limit of complexity has not yet been reached, and that there may be two intermediate products instead of only one.

Engineering for September 17 has a concluding article on worm-gear in which is contained the discussion on an important paper by Mr. F. W. Lanchester, reprinted in previous articles. The Lanchester worm is of the hollow type, and very careful tests reveal very high and consistent efficiencies. The preservation of the oil film between the surfaces in contact is all-important, and it is possible that the film can be kept better in place with a hollow worm than a parallel one. Mr. Lanchester says that for the purposes of discussion the surfaces in contact in his worm-gear may be represented by ellipses of elongated form. The motion is broadside, and the pressure is continually exerted on a region to which the oil had just previously been squeezed, so that the surface continually floated on an oil film instead of sinking through it. With light pressures this action is not important, but when the pressures exceeded half-ton to one ton per square inch the squeezer action became important. The gear was applied to the Lanchester car in 1897, and had been fitted to every Lanchester car since that date.

THE Manchester Literary and Philosophical Society has published a catalogue of the serial publications in its library. The catalogue has been compiled under the direction of the honorary librarian, Mr. C. L. Barnes, by the librarian, Mr. A. P. Hunt. The total number of current publications at present received by the society is 810; and these, together with a number of serials no longer in progress, have all been dealt with. To facilitate the finding of any individual work, a copious index has been added, in which each town, institution, and title of publication is mentioned separately.

OUR ASTRONOMICAL COLUMN.

THE SUPPOSED NEW COMET.—Ephemeris Circular No. 492 of the *Astronomische Nachrichten* contains a notice from Prof H. Kobold, Kiel, announcing that Prof. Frost has identified the supposed new comet discovered by Mr. J. E. Mellish on September 6 with N.G.C. 2261.

STAR COLOURS.—There are two methods by which the colours of stars are being determined:—(1) the direct method, in which a coarse objective grating is used, and estimates made of the mean effective wave-lengths of the light from the stars; and (2) comparison of the relative intensities of two separate regions of the stellar spectrum. As usually effected, this is an indirect method, based on measures of photographic and visual (or photovisual) magnitudes. Three recent contributions from Mount Wilson Observatory, (*Astrophysical Journal*, vol. xli., No. 1) deal with this subject. In one of these Prof. E. Hertzsprung presents an account of his researches on the stars in the cluster N.G.C. 1647 by the grating method used in conjunction with the 60-in. reflector of the Mount Wilson Observatory. Photometric magnitudes and effective wave-lengths are given for rather more than 200 stars in the cluster. In the case of 44 stars, a comparison of the measures of effective wave-length are compared with a rough classification of the spectrum. Partly from this paper, Mr. F. H. Seares derives data for a comparative study of colour-indices measured indirectly with those obtained by transforming effective wave-lengths. Results for 47 stars of magnitudes between 11·5 and 15 indicate that for this interval the two series of colour-indices show the same increase in mean colour with increasing magnitude. In the remaining paper, Prof. Hertzsprung discusses the mean effective wave-length of a number of absolutely faint stars. Effective wave-lengths show little change for stars of abs. mag. +3 and +8, the values lying between $\lambda\lambda$ 4500–4600. The suggestion is made that the abs. mag. +3, corresponding to a temperature of 3400° abs. for a black body the size of the sun, represents the stage of a cooling star at which relatively dark solid matter begins to form on its surface.

RAIES ULTIMES.—Comte A. de Gramont designates by this term those lines in the spectrum of an element which for any given source of luminescence persist longest as the percentage of the element is reduced. They are thus lines of maximum sensitivity. In a paper lately published (*Ann. Chem.*, vol. iii., May–June, 1915) it is pointed out that the effect of reduction of quantity of substance should not be confounded with diminished exposure in photographing the spectrum. The one operates on the spectrum, the other acts merely on the record. The persistent lines are not identical in the two cases. It appears that in general the vestigial spectrum is not of necessity made up of remnants of the strongest lines of the elements, though, in fact, the *raies ultimes* mostly seem to be either the strongest or among the strongest lines, and they are usually lines which readily reverse. They bear some sort of relationship to the "long" lines employed by Sir Norman Lockyer some forty years ago as criteria to establish the presence of less spectroscopically conspicuous elements in the sun. The paper contains interesting suggestions regarding the energy distribution in line spectra and on the relationship between the *raies ultimes* and the point of maximum radiation.

EARLY NAUTICAL ASTRONOMY.—An address on the beginnings of geographical science, delivered by Sir Clements R. Markham before the Royal Geographical Society on June 10 last (*Geographical Journal*, vol. xlvi., No. 3, September, 1915), contains much extremely interesting information regarding the development of astronomical methods, instruments and tables, employed in navigation during the period of revival of nautical adventure; the period of the first Transatlantic voyage, and the rounding of the Cape of Good Hope. It was, in fact, the efforts of the Portuguese to open up the western coast of Africa, leading seamen into southern waters out of sight of the familiar Polaris, that necessitated the formulation of new methods. A mathematical Junta appointed by King Joâo II. of Portugal (1481–95) triumphed over the difficulties. It now appears that a Jewish royal physician was the leading spirit of the commission, and it was a friend of his, Abraham Zacuto, professor of astronomy at Salamanca, who had ready at hand the requisite tables giving the sun's declination. Lack of space forbids further description here. The lecturer drew largely on the researches of Senhor Joaquim Bensaude, in particular on the latter's work "L'Astronomie nautique au Portugal à l'époque des grandes découvertes," Bern, 1912.

APPROXIMATE DETERMINATION OF PLANETARY LONGITUDE.—In *Knowledge* (August) Prof. Herbert Chatley gives a simplified method of calculating planetary longitudes for elliptic orbits without employing intricate mathematics. The method depends on the assumption, apparently very nearly true, that the difference between uniform circular motion and elliptic is harmonic. It is claimed that the method is capable of giving results to within a few minutes of arc.

THE CANADIAN ARCTIC EXPEDITION.

MR. VILJALMUR STEFANSSON, the Canadian Arctic explorer, whose unexpected safety is announced, contributes his personal narrative of the expedition to Monday's *Daily Chronicle*. He left Alaska in July, 1913, for the Beaufort Sea. Bases were also to be established on Prince Albert Sound and Patrick Island. Mr. Stefansson was accompanied by Dr. Forbes Mackay and Mr. James Murray, of Shackleton's first Antarctic expedition; M. Henri Beuchat, a French anthropologist, who was to study the Eskimo of Bank Land; Mr. W. L. McKinlay and others. Captain Bartlett, of Peary's North Pole expedition, was in charge of the *Karluk*, the main ship of the expedition. Whether or not the *Karluk* could reach Patrick Island and penetrate the Beaufort Sea depended on the prevailing winds. With a persistence of easterlies, which Stefansson hoped for, this would be possible, but otherwise he realised that his plans must be modified.

Early in August, 1913, the *Karluk* was beset in the ice in 147° W., fifteen miles off the shore. In the belief that the ship was firmly frozen in, Stefansson, with three companions, went ashore to hunt towards the end of September. During their absence a strong north-easterly gale broke up the ice and carried the ship away to the west. Passing near the coast firmly beset in the ice the *Karluk* was carried north-westward to 73° N. 162° W. on November 11. Her drift then changed to south-west, and by the end of the year she was sixty miles north-east of Herald Island. Two weeks later the ship was crushed and sank, but not before a quantity of stores had been placed on the ice. Herald Island could not be approached on account of open water, so tracks were made successfully for Wrangell Island. A party of eight, however, including Dr. Mackay, Mr. Murray, and M. Beuchat, who had left the *Karluk* earlier in an attempt to reach

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Herald Island, failed to turn up. Captain Bartlett crossed Long Sound and with great difficulty reached the Alaskan coast, which he followed eastward to Emma Harbour, whence a whaler took him to St. Michael. From there a relief ship set out to Wrangell Island and brought back the remaining survivors of the *Karluk*. Three of the party had died on the island, and later search failed to reveal any trace of Dr. Mackay and his party, all of whom probably perished by falling through the ice.

Meanwhile Stefansson had attempted to retrieve the fortunes of the expedition. After a winter in the Mackenzie delta (1913–14), he set out northward over the ice with seven companions, starting from Martin Point, 140° W., on March 22, 1914. Three weeks later the supporting party turned back, bringing news that Stefansson meant to continue northward for at least another fifteen days. A small vessel, the *Polar Bear*, searched for them along the coast of Banks Land last year, but found no trace, and it was generally supposed that Stefansson and his party had perished until the news came last week. Travelling over the ice, and often drifting with it, the party reached 73° N., 140° W. Stefansson then decided to turn eastward, and ninety days after leaving Cape Martin landed on Banks Island, thirty miles south of Cape Alfred. From there he went south to Cape Kellat and met his supply ship. In the winter a four-hundred mile sledge journey to Victoria Island failed to reveal Eskimo. In February this year Stefansson, with three companions, set out northward *viâ* Cape Alfred to Patrick Island, and up its eastern side to Cape McClintock. To the north-east they discovered an extensive new land rising to a height of 2000 ft. The return journey was along the west coast of Melville Island, across McClure Strait, to the Bay of Mercy, and thence across Banks Island to Cape Kellat. From there Stefansson reached Herschell Island in the *Polar Bear*. Throughout his travels he lived chiefly on caribou, bears and seals, and suffered no want. He has since returned to Banks Island, and next year intends to explore his new land, and to make a journey over the Beaufort Sea. Surveys were made of the lands visited, and the work of Sir Robert McClure amplified and extended. R. N. R. B.

THE STANDARDS AND FUNCTIONS OF MUSEUMS.

OUR forefathers regarded museums simply as storehouses for freakish, reminiscent, or merely curious objects, and as the place in which to deposit the various oddments presented by travellers abroad. There was no "purpose" in the display of the objects exhibited, other than that of perchance amusing stray visitors. So far as this country is concerned, the new era of museum management began with the foundation of the British Museum at Bloomsbury, when the first attempt was made to eliminate the purely "showman" element and substitute meaning and purpose in the arrangement of its contents. As compared with the Continental museums, it stands easily first in the character of its endeavours to interest, as well as instruct, the public. But in this we have serious rivals in the museums of the United States, as may be gathered from the forty-sixth annual report of the American Museum of Natural History. In this, and other similar institutions in America, huge sums are spent on large groups of mammals and birds mounted to reproduce the exact environment in which such animals lived. And this illusion is further heightened by skilfully painted backgrounds, executed by artists who accompany the collectors in order that they may reproduce the actual environment in which the specimens lived. This, however, is but an extension of the methods of exhibition introduced by the British Museum many years ago.

In exhibitions designed primarily to instruct rather than to amuse, it is an open question whether our rivals are not over-reaching their ideals—at any rate, in so far as the work of a natural history museum is concerned. Mineralogy, for example, no doubt must find a place here, but large models of a copper mine, such as that reproduced here, and the method of raising ore, would seem to have a more appropriate place in a museum of technology.

The students' collections of such museums must either be of insignificant proportions, or the staff must be much larger than that attached to museums in

Copper Queen Mine Model, Department of Geology and Invertebrate Palæontology. The American Museum of Natural History.

Great Britain, otherwise the curatorial work in connection therewith would make it impossible for the staff to devote so large a portion of their time to work which is done, indifferently well, it is true, in this country, under the auspices of the Board of Education, as "Nature-study." That this should be so is unfortunate, for, as a means of awakening the intelligence and powers of observation, there is no more efficient aid than the study of natural history, using this term in its widest sense.

In addition to lectures to children and teachers, special rooms are set apart in American museums for children's collections, while this work is supplemented by travelling museums sent round from school to school by means of motor-vans. Something of this kind could well be imitated in this country.

The department of public health in the American Museum of Natural History answers to no more than one aspect of the department of economic zoology of the British Museum of Natural History—that which concerns the organisms injurious to man—for no attempt seems to have been made to bring together a collection of domesticated animals. On the other hand, our rivals are ahead of us in having instituted

an exhibition of living bacteria such as more or less affect the well-being of the human race.

It is to be hoped that this report will be widely read in this country by all who are concerned with the management of museums, for it is full of most valuable information, and it is becoming increasingly clear that the museum is becoming more and more a factor in the well-being of the community. W. P. P.

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THE BRITISH ASSOCIATION.

SECTION C.

GEOLOGY.

OPENING ADDRESS[1] BY PROF. GRENVILLE A. J. COLE, F.G.S., M.R.I.A., PRESIDENT OF THE SECTION.

THE geologist has long been accustomed to regard the crust beneath his feet as subject to changes which are immeasurably slow in comparison with the duration of his personal life. James Hutton has sometimes been charged with catastrophic tendencies, in requiring a complete wearing away of the continents, followed by a somewhat sudden restoration of the land-surface. But he was careful to urge[2] that "the powers of nature are not to be employed in order to destroy the very object of those powers; we are not to make nature act in violation to that order which we actually observe." He remarks[3] that "this world is thus destroyed in one part, but it is renewed in another; and the operations by which this world is thus constantly renewed are as evident to the scientific eye as are those in which it is necessarily destroyed." Yet the operations that are to "give birth to future continents," as well as those that wear down a continent to the level of the sea, are not the result of "any violent exertion of power, such as is required in order to produce a great event in little time; in nature, we find no deficiency in respect of time, nor any limitation with regard to power." Far from believing in the complete loss of the former land-surface before upheaval raised the new, Hutton points out that "the just view is this, that when the former land of the globe had been complete, so as to begin to waste and be impaired by the encroachment of the sea, the present land began to appear above the surface of the ocean. In this manner we suppose a due proportion to be always preserved of land and water upon the surface of the globe, for the purpose of a habitable world, such as this which we possess."

Changes in the Relative Proportions of Sea and Land.

Few geologists, however, will now urge with Hutton that a "due proportion" has always been preserved between land and water on the surface of the globe, if by those words is meant a proportion such as we now enjoy. If we go back to early times, we must consider, with R. A. Daly,[4] the possible grouping of the land against which the Huronian or late pre-Cambrian sediments were formed. Daly has imagined, as one of the causes contributing to a "limeless ocean," a primitive distribution of land and water very different from that which determines our continental land to-day. His pre-Huronian land-surface is pictured as merely a number of large islands, on which no long and conspicuous rivers could arise.

It may be said that this primitive condition of the distribution of land and water is very unlikely to return. But we have evidence that Hutton's "due proportion" has been interfered with from time to time. The very general spread of the sea over the land-margins in Cenomanian times is attributable to a shallowing of the ocean-floors, and it is difficult to say whether this process has been rhythmic or exceptional in the history of the globe. The Carboniferous period opened with marine conditions over a large part of the northern hemisphere, indicating, not only a continuation of the Devonian seas, but an overflowing of much of the Caledonian land. The same period closes with an extension of the continental edges, and the formation of swampy flats, in which the vegetation of the epoch has been abundantly preserved. Similarly, the sea which deposited the Cretaceous strata, after encroaching alike on South Africa and Scandinavia, withdrew to a considerable extent in Eocene times.

The Foundations of the Earth's Crust.

Hutton remains at present unassailable in one of his most remarkable propositions. For him, the oldest rocks that we know are sedimentary, and these sediments differed in no respect from those of modern days. This conclusion has perhaps not received the full attention it deserves. It now appears

[1] Abridged by the author.

[2] "Theory of the Earth" (1795), vol. ii., p. 547.

[3] *Ibid.*, p. 562.

[4] "The Limeless Ocean of Pre-Cambrian Time," *Amer. Journ. Sci.*, vol. xxiii. (1907), p. 113; and more fully in "First Calcareous Fossils," *Bull. Geol. Soc. America*, vol. xx. (1909), p. 157.

certain that we possess no record of a sedimentary type peculiar to the early stages in the formation of a habitable crust. If such a type existed, it has been lost to us through subsequent metamorphism, amounting to the actual fusion and redistribution of its constituents. The Grenville Series of North America rests on a floor of granitoid rock, which is intrusive in it, and which belongs to the oldest of various irruptive groups. The Grenville Series includes conglomerates, false-bedded quartzites, and a development of limestone that is altogether exceptional for pre-Cambrian times. In Finland,[5] sediments have been traced down to the layer where their original characters vanish in a general "migmatitic" ground. Conglomerates and phyllites occur among them, and near Tampere (Tammerfors) the seasonal stratification is as well recorded in a Bottnian shale as it is in the Pleistocene clays made famous in Sweden by De Geer. Vein-gneiss (Adergneis) underlies these ancient systems, and represents their destruction by the injection of granite from below. If we accept the hypothesis of Chamberlin, Hutton's position becomes strengthened by the postulation of an unfused planetesimal crust, and the restriction of molten masses and hydrothermal activity to the interior of a consolidating globe.

So far as we have any record left to us, Hutton remains fundamentally in the right. All modern research shows that the schists and gneisses can be explained by causes now in action. The vast majority of schists were at one time normal sediments; others were tuffs or lavas; but, whether originally sedimentary or igneous, they owe their present characters to widely spread regional metamorphism.

The Undermining and Weakening of the Foundations of the Crust.

Is there, then, any reason to depart from Hutton's position as to the recurring cycle of events in the history of continental land? I think it must be admitted that the isostatic balance was far more frequently disturbed in what we may call Lower pre-Cambrian times than it has been in more recent periods. Local fusion must be regarded as an important cause of crustal weakening. If we wish to study the nature of the process, it is reasonable to examine regions that have at one time lain deep within the crust. Such regions are provided by the broad surfaces of Archæan rocks that were worn down through continental decay before they sank beneath the Cambrian sea.

It is well recognised that an ancient continent at one time stretched across the northern hemisphere. Wherever later deposits have been stripped from its surface, from central Canada to the Urals, and probably far beyond, we find that the older materials of this undulating continental platform consist largely of intrusive igneous rocks. These, moreover, have frequently a gneissic structure. Again and again, strongly banded gneisses occur, in which granitic material, verging on aplite, alternates with sheets of hornblendic or biotitic schist. The biotitic varieties can often be traced back into amphibolites. In places, lumps of these amphibolites are seen, streaked out at their margins, and providing a clear explanation of the dark bands throughout the gneiss.[6]

[5] J. J. Sederholm, "Ueber eine archäische Sedimentformation im südwestlichen-Finland," *Bull Comm. géol. Finlande*, No. 6 (1899), p. 215.

[6] Since the historic works of A. C. Lawson (for example, "Report on Rainy Lake Region," *Geol. Surv. Canada*, Ann. Report for 1887, plates v. and vi.), these features have been traced in many areas. Compare W. H. Collins, "Country between Lake Nipigon and Clay Lake, Ontario," *Geol. Surv. Canada*, Publication 1050 (1909), p. 52; A. L. Hall, Presidential Address on the Bushveld Complex, *Proc Geol. Soc., S. Africa*. 1914, xxii; P. A. Wagner on Rhodesian gneisses, *Trans. ibid.*, vol. xvii., 39; and works cited in the next reference.

This swallowing up of a mantle of basic material by a very different and highly siliceous magma rising from below is, indeed, seen to be a world-wide feature, wherever we find the lower crust-layers brought up within reach of observation. The tuffs and lavas of the Keewatin series have supplied the dark material in Canada, and similar rocks have been worked up into the gneisses of Galway, Stockholm, and Helsinki. The frequency of amphibolite in these ancient composite rocks is explained by the fact that this type of rock is the final term of various metamorphic series. While many lumps, for instance, in the gneisses of Donegal are residues of Dalriadian dolerites (epidiorites), others, rich in garnet and green pyroxene, and often containing quartz, are derived from a mixture of sediments in which limestone has been prevalent.[7] During the absorption and disappearance of these masses in the invading granite magma, the amphibole acquires potassium and breaks down into biotite, and biotite-gneisses result, which may extend over hundreds of square miles.

The details of such an igneous invasion are worthy of careful study, since only in this way can we follow out the progress of subcrustal fusion. We see the highly metamorphosed material further attacked by the great cauldrons under it, and becoming seamed with intersecting veins. Block after block has been caught, as it were, in the act of foundering into the depths. In the gradual absorption of these blocks, and their penetration by insidious streaks of granite, we see pictured on a few square yards of surface the destruction of a continental floor.

The invasion of a "hard and brittle"[8] crust by an attacking magma was finely described by Lawson in 1888. Lawson pointed out that the Laurentian gneisses gave no evidence of having "yielded to pressures and earth-stresses." The folding of the overlying series was prior to the solidification of the gneisses, and occurred[9] "while the latter were yet in the form of probably a thick, viscid magma upon which floated the slowly shrinking and crumpling strata of the Coutchiching and Keewatin series. . . . Large portions of these rocks have very probably been absorbed by fusion with the magma, for the Laurentian rocks appear to have resulted from the fusion not simply of the floor upon which the Coutchiching and Keewatin rock first rested, whatever such floor may have been, but, also, with it, of portions of those series."

The conversion of the lowest Archæan series, the Coutchiching sediments, into crystalline schists is attributed to thermal metamorphism, and to hot vapours streaming from the molten floor. Lawson realised the importance of shattering in allowing a magma to advance into an overlying "brittle" series, and he is, so far as I know, the first observer to develop in satisfying detail what is now known as the stoping theory of igneous intrusion.

James Hutton always had in mind the effect of heat in "softening" lower layers of the crust. His consolidation of strata by heat is preceded by a stage of melting. Sederholm,[10] while referring back to Hutton as the pioneer, shows how in the vein-gneiss

[7] See Michel Lévy, "Granite de Flamanville," *Bull. carte géol. France*, vol. v (1893), p. 337; G. A. J. Cole, "Metamorphic Rocks in E. Tyrone and S. Donegal," *Trans R. Irish Acad.*, vol. xxxi. (1900), p. 460; O. Trüstedt, "Die Erzlagerstätten von Pitkäranta," *Bull. Comm. géol. Finlande*, No. 19 (1907), pp. 72 and 92; F. D. Adams and A. E. Barlow, *op. cit.* (1910), pp. 25 and 97; "F. Kretschmer, "Kalksilikatfelse in der Umgebung von Mährisch-Schönberg," *Jahrb. k k. geol. Reichsanstalt*, vol. lviii. (1908), p. 568; etc.

[8] A. C. Lawson, *op. cit.*, p 140. See also his revision of the area, *Geol. Surv. Canada*, Memoir 40 (1913).

[9] *Op. cit.* on Rainy Lake, p. 131.

[10] "Ueber eine archäische Sedimentformation im südwestlichen Finland," *Bull. Comm. géol. Finlande*, No. 6 (1899), p. 133; and "Ueber ptygmatische Faltungen," *Neues Jahrb. für Min.*, Beilage Band 36 (1913), p. 491.

stage the unmelted sediments exhibit plasticity and become intensely contorted. The softening, in fact, induces flow. There is here no crushing or mylonitisation, but rather a viscid running of constituents, some on the verge of fusion, some, I venture to think, actually fused. Such rapidly repeated and intricate folding is most intense when *lit par lit* injection has set in, and when the whole composite mass has become weak and plastic. The presence of confined water in aiding this plasticity must on no account be overlooked.

It may be well to illustrate this contention by one or two concrete instances from districts not remote from us at the present time. The noble cliffs of Minaun in Achill Island have been worn by the Atlantic from a mass of evenly-bedded quartzites of Dalriadian age. These are invaded by veins of a very coarse red granite, the main mass of which lies below the present sea-level.[11] The edges of the strata appear fairly horizontal on the cliff-face; but contortion sets in towards the base, and the hard resisting rock has here[12] "undergone intense crumpling and overfolding, such as one meets with on a large scale in mountain ranges, and this contorted flow seems entirely due to the yielding that has taken place in the region of heating." The large size of the constituent crystals of the granite indicates that the surrounding rock was still maintained at a high temperature.

South of Foxford, again, in the county of Mayo, the granite of Slieve Gamph invades a series of mica-schists and quartzites. The margin is cut, as usual, by veins that filled the cracks both of the main granite and the metamorphosed sediments. These sediments have become, prior to the shattering, crumpled and overfolded along the contact-region, and the section upon the glaciated slope resembles that of a fluidal rhyolite on a highly magnified scale.

The wonderful contortion of the composite mass that forms the north end of the Ox Mountains (Slieve Gamph) in the county of Leitrim gives a similar impression of viscid flow. The melting of a single constituent of the invaded schists, which here include amphibolites, would enable them to yield in response to the pressures that were forcing the granite magma in thin sheets between them. Their metamorphism is thermal, and the forces that have produced the crumplings are not those of shearing acting on a solid mass, but may have operated from a distance hydrostatically through the magma.

Again, where limestones occur near granite contacts amid a series of various sedimentary types, they display folded structures in an altogether exceptional degree. Silicates have developed along their bedding-planes, but these have become contorted and rolled upon one another as metamorphism reached its maximum stage. At Maam Cross and Oughterard, in the county of Galway, along the margin of the great granite mass that stretches thence southward to the sea, these flow-structures are conspicuous on weathered surfaces.

The main object of the foregoing discussion is to point out that the Huttonian cycle, in which thermal changes play so large a part, implies a serious weakening of the crust as magmas advance into it from below. The extensive metamorphism of the pre-Cambrian strata, which amounts to a distinctive feature, must, I think, be attributed, not to special intensity of tangential pressures in early times, but to frequency of igneous attack. Much of the crumpling of our schists may result from Hutton's "softening," the pressure being supplied from superincumbent masses, or even hydrostatically, and the flow occurring laterally, or vertically downwards, towards regions where destruction by absorption was going on. The features seen during the falling in of the walls of the lava-lake of Kilauea in Hawaii afford some idea of what takes place in zones of melting within the crust.

Under such conditions in early pre-Cambrian times, even the surface-rocks must have fallen in at some points and have been replaced by igneous extrusions. Isostatic adjustments must have been very frequently disturbed. Folding of rocks, as a phenomenon of lateral surge and flow, must have made itself freely felt at the earth's surface. It is safe to assert that such conditions have not been repeated on a broad scale at any geological period subsequent to the spread of the Olenellus-fauna. Geochemical evolution, however, may have surprises still in store, and, in spite of long tradition, we are disinclined nowadays to rely too strongly on arguments based upon the sanctity of human life.

Possible Breaks in the Slow Continuity of Earth-movement.

1. *The Mountain-building Stage.*

Even with the thickened sedimentary crust beneath us, and the confidence inspired by our limited experience of the earth, we may ask if subterranean changes may not still result in catastrophes at the surface.

What, in fact, is likely to occur if a mountain-building episode again sets in? Such episodes, affecting very wide areas, have undoubtedly recurred in the earth's history. We do not know if they are rhythmic; we do not know if they represent a pulsation, decreasing in intensity, inherited from the stars and hampered by increasing friction; we do not know if they record internal chemical changes, which have no climax, because they are neither cyclic nor involutionary, but evolutionary. The mid-Huronian chains, now worn down and supplying such valuable horizontal sections, were evidently of great extent; but we cannot say that they were vaster than those of later times.

The phenomena accompanying the growth of a single chain in the Cainozoic era give us, at any rate, ample food for thought. Though the narrow cross-section of the core of such a chain limits our field of observation, the same inpressings of igneous material, and the same features of rock-weakening and rock-destruction, may be observed as in the immense basal sections exposed in the Archæan platforms. The progress of geological time has not diminished the activity in the depths. The granodiorite of western Montana,[13] for instance, which intruded during an uplift in early Eocene times, has attacked the Algonkian sediments of the district, producing phenomena of stoping and assimilation in the true "Laurentian" style.

In the western and central Alps, again, the absence of any fossiliferous strata older than the Carboniferous arouses some surprise, until we find that many of the granitic intrusions are of late Carboniferous age. The crystalline schists west of Časlav in Bohemia and in the Eisengebirge are now attributed by Hinterlechner and von John[14] to the metamorphism of Ordovician strata by younger granite, which intruded in post-Devonian and probably in Carboniferous times. Much of the gneiss and granite of the Black Forest and the Vosges is now, moreover, removed from the Archæan, and is shown to be associated with the Armorican movements.[15] These vast intrusive

[11] *Proc. Geol. Assoc.*, vol. xxiv. (1913), Plate 17.

[12] G. A. J. Cole, "Illustrations of Composite Gneisses and Amphibolites in N. W. Ireland," *C. R. Congrès géol. internat.*, Canada (1913), p. 312.

[13] J. Barrell, "Marysville district, Montana: a study of igneous intrusion and contact metamorphism." *U.S. Geol. Survey*, Prof. Paper 57 (1907), and W. H. Emmons and F. C. Calkins, "Phillipsburg Quadrangle," *ibid.*, Paper 78 (1913).

[14] *Verhandl. k. k. Reichsanstalt*, 1910, p. 337, and *Jahrb.*, *ibid.*, vol. lix. (1909), p. 127.

[15] P. Kessler, "Die Entstehung von Schwarzwald und Vogesen," *Jahresberichte Oberrhein, geol. Vereines*, vol. iv. (1914), p. 31.

masses occupy the place of strata of pre-Permian age. The great development of thermal metamorphism in the Erzgebirge and in Saxony,[16] two classic regions of the dynamometamorphic school, is now widely recognised, and this activity is also assigned to late Carboniferous times. The work of C. Barrois in Brittany is concerned with absorption-phenomena resulting from intrusions during the same mountain-building epoch.

Sederholm[17] has suggested that the ground above an area affected by processes of mountain-building cracks and becomes faulted, while the more plastic zone below flows under pressure into folds. But the blocks of the "brittle" layer, as Lawson has it, may be seriously displaced by movements in the zone of folding, and subsidences of a regional character may occur. The pressure that has driven an excess of matter to the region of overfolding has squeezed it from beneath an adjacent region. Crumpling and overfolding are accompanied by a shearing away of the matter in one zone from that of another which overlies it; this must result in considerable disturbance of the zone nearer the surface.

We usually regard such disturbances from the uniformitarian point of view. May not, however, actual mountain-building be the break in a slow process of "softening," to use Hutton's term? For a long time the isostatic balance suffers only small disturbances, restoring itself automatically on a gently yielding underworld. Then something gives way; something—a large mass of supporting rock—suffers a change of state. The balance is destroyed abruptly, and mountain-building and rapid subsidences have their day. O. Ampferer,[18] with his customary largeness of view, has referred superficial evidences of disturbance, such as mountain-ranges, to dragging movements of a mobile *Untergrund*. He urges that physical and chemical changes within the earth may produce considerable local changes of volume. Vertical movements lead to upfolding, and this leads to gravitational sliding. The zone of folding that we have been considering as normal near the *Untergrund* thus becomes transferred to the surface of the earth.

I am not now concerned with the causes of folding, beyond the fact that at a certain critical stage the material involved may move at a rapid rate. Changes of state, physical and chemical, occur with some abruptness. In the case of rocks, the softening or melting of even one constituent may allow of flow, and, as we have observed, this flow in a lower layer may soon become manifested in surface-changes.

Ampferer and Hammer[19] have recently considered the overfolded structure of mountains as due to a considerable local reduction in volume of the *Untergrund*. The upper crust presses inwards from opposite sides, and the parts that are thrust downwards become absorbed and carried away with the retreating region of the *Untergrund*. The surviving parts fall over on either side, producing, as the whole continues to close in, folds that are not so very different from the now familiar ***nappes de recouvrement*** which these authors hesitate to accept. The important point for our present purpose is the restatement of the results of gravitation on the flanks of an uprising chain.

The surprising thing about our folded mountain-chains is the way in which they have been eroded parallel to the strike of the overthrust sheets or overfolds. Apart from occasional detached "klips," the distal parts of these masses must have been at one time continuous with those proximal to the root-region. The forward movement could not have occurred if denudation had negatived the effects of folding on the surface.

The marine or lacustrine deposits of the age immediately preceding that of uplift obviously cannot be consolidated at the epoch of upheaval. Gotlandian sands and muds must have overlain the heaving masses that rose as Caledonian land. The swamps of the Coal Measures were contorted in the Armorican chains: the highest beds of these must have been as yielding and as capable of flow as the Flysch that overlay the growing Alps. In all these cases, familiar to us in Europe, the covering masses must have responded to the crumpling under them, and, when reared to dangerous eminences, rapidly became a prey to denudation and gravitational downsliding. They can scarcely be regarded as protective, and their removal would leave the brittle masses below more liable to fracture and to the "calving" process that forms klips.

In some cases separation seems to have taken place as the moving mass fell forward. The klips of hard material embedded in softer strata are thus a kind of rock-spray, hurled in advance of the breaking earth-wave.

Termier[20] in no wise fears to speak of the progress of a "traîneur écraseur" during mountain-building as "soudain et rapide comme une rupture d'equilibre, le dernier acte, longuement pépar*é*, mais joué d'*emportement*, de ce drame grandiose."

Rupture combined with rapid movement of the rocks need not be the last act of the drama; but, the more we examine the history of folded chains, the more probable it appears as a culminating episode. The original cover of our present ranges has been lost by denudation. Earth-sculpture in these regions of high altitude and vehement attack has removed much of the evidence that we seek. What remains, however, may lead us to feel that no part of the world in historic times has experienced a mountain-building episode.

Such relatively catastrophic stages have, indeed, not been common in the long history of the earth since pre-Cambrian times. It appears that now and again the "orogenic collapse" of some considerable area disturbs the balance in the crust and spreads far through the upper layers like a disease. Or it may be that the thermal cause of the collapse is common to the whole earth at the same time, and becomes manifest in responsive regions far apart. In any case, the weak places give way and the more resisting ones close in. A readjustment is effected, which then endures through long geological time.

The imminent menace of crustal changes was brought home to us during the terrible period from April 4, 1905, to January 14, 1907, the final twelve months being marked by a veritable earth-storm. Geologically speaking, however, we are near enough to the Tortonian epoch to look forward with some confidence to a quiescent phase. But some day, in its due season, the earth will once more be active. When that time comes, no ingenuity of man will suffice to meet it. Earthquake after earthquake, increasing in intensity, will probably have driven the population to a distance from the threatened zone. Concentration of the folding along a particular earth-line will limit the region of absolute destruction; but the undulations spreading from it, in response to the heavings of the chain, will offer sufficient chances of catastrophe. In the case of our youngest mountain-ranges, these undulations remain perpetuated as domes

16 C. Gäbert, *Zeitschr. deutsch. geol. Gessell.*, vol. lix. (1907), p. 308; R. Lepsius, "Geologie von Deutschland" (1910), pt. 2, pp. 107 and 172.

17 *Op. cit.*, *Bull. Comm. geol. Finlande*, No. 37, p. 66.

18 "Das Bewegungsbild der Faltengebirgen," *Jahrb. k. k. geol. Reichsanstalt*, vol. lvi. (1906), p. 607.

19 O. Ampferer and W. Hammer, "Geologischer Querschnitt durch die Ostalpen," *Jahrb. k. k. Reichstanstalt*, vol. lxi. (1911), p. 700.

20 "Les Problèmes de la Géologie tectonique dans le Méditerranée occidentale," *Revue générale des Sciences*, March 30, 1911.

and dimplings of the crust, which are already worn down or infilled respectively by denudation and deposition. Their present forms and places record the last movements of the earth-storm, just as a buckled tramway-rail records the passage of an earthquake. How shall we gauge to-day the intensity of their rise and fall?

In the case of the city devastated by an earthquake, the débris is cleared away, and our descendants in time discover the distorted rails beneath the healing mantle of new grass. Will they realise from this alone the preliminary tremors, the sudden arrival of the culminating vibration, the shock that overcame the elasticity of the crust beneath them, and then the gradual establishment of the conditions under which they have passed their peaceful lives? The crumpled wreckage lies there in evidence before them; but how will they distinguish the work of a few stormy seconds from that due to the gentle earth-creep of a century?

(2) *Regions of Subsidence.*

It was probably E. Suess who brought home to most of us the importance of regions of subsidence in defining the lowlands and the sea-basins from the upstanding masses of the crust. While one region may be folded, another may be broken into blocks; and the two types of movement, that due to tangential thrusting and that due to vertical uplift and down-faulting, may appear in the same region and may alike play their part in producing a lowering of large areas. The domes and dimples that occur beyond the region of acute crumpling may be intensified into fault-blocks by fracture of their boundaries. If catastrophes are possible during uplift, we may look for them also during subsidence.

The cutting-up of mountain-chains by transverse fractures has resulted in the loss of huge blocks beneath the sea. In such cases it is clear that faulting has run a long way ahead of denudation. All trough-valleys, which are often called, somewhat misleadingly, rift-valleys, raise the same questions as to the nature of the steps by which they have been produced. The Rhine Vale, one of the most closely studied examples, dropped 8000 ft. within the limits of Oligocene time. It is improbable that the numerous faults now traceable operated with concerted gentleness.

Abruptness of certain Geographical Changes.—River-capture.

There is a totally different class of terrestrial phenomena which lends itself also to speculation, or to that imaginative faculty, proper to our Section, which enables the geologist to reconstruct. Geographers have taught us to speak lightly of river-diversion and river-capture, and to treat them as frequent occurrences in the history of existing lands. It is interesting to inquire what this process on a large scale may involve.

The draining of the Ragunda lake in Sweden [21] in 1796, by the rapid cutting of a ravine 100 ft. deep in a soft barrier, shows how many of our Glacial lakes, dammed by morainic matter, may have excavated their outlet gorges and run dry in the course of a few hours. The history of the temporary lake behind the Gohna landslip, so brilliantly studied by our vice-president, Sir Thomas Holland,[22] provided a lesson both in hill-destruction and catastrophic flooding. The diversion of the Colorado River, however, in 1905, into the sluice leading to the Salton Sink gives us a definite illustration of river-capture. The "New River" thus produced in the depression to the north-west of Calexico cut a valley 70 ft. deep through the agricultural land that it was meant to serve, and worked the head of this valley backward at the rate of a third of a mile a day.

One of the most remarkable instances of river-diversion in the European record is that of the waters from the north side of the central Alps. At the close of the Pliocene period, the north slopes of the St. Gothard mass and the Bernese Alps, supplying the torrents of the Reuss-Aar-Saane system, drained across the hummocky land near Bâle and sent their waters over to the Doubs. The great Rhine-trough drained southward, and its streams formed tributaries of the Alpine flow near Bâle. The Mainz basin, however, which was infilled by Lower Pliocene alluvium, became tapped by the head of a river that had long run northward from the Hunsrück-Taunus range. This river is the Rhine that we know north of Coblenz, and its alluvium was then spread out where the sea now stretches between Holland and the Yorkshire coast. Its mature valley is still traceable [23] above the present stream-cut in the hills. This river could have no direct influence on the course of the drainage from the Alps. But the bulging of the land at the north end of the Juras still continued. As the text-books remark with some complacency, the Burgundian gate was closed, and the river that had previously crossed westward was diverted northward to the Rhine-trough.

Can we exactly picture what this means? The whole Reuss-Aar-Saane system "on some particular day began to flow northward along the far older tectonic trough, carving away the infilling of detritus, washing back tree-stems that were floating quietly from the Lake of Mainz on their way to the Mediterranean, and finding, when it reached that lake, a notch sufficiently low for its escape across the Hunsrück-Taunus range. An enormous body of water was thus added to that which had formed in Pliocene times a mature valley across these hills." [24] The system indicated above, representing the flow from a hundred miles of snow-clad mountains, must have made a remarkable change in the stream across the Armorican hills. When the Alpine water arrived at the Mainz basin, and found its way into the notch formed by the Pliocene Rhine, it poured down upon the forest-covered delta-land. The changes that have occurred in the unconsolidated ground of Holland in historic times furnish some picture of what must have happened in the prehistoric delta of the Rhine. Land was suddenly built up at some points, islands were carved out at others, and the effects of the catastrophe must have been still manifest when the Scandinavian ice-sheet began to invade the mud-flats from the north.

The capture of a large river may be illustrated by the story of the Vistula. This noble stream represents in a remarkable way the drainage of 190 miles of the Carpathians. All this water becomes concentrated, at the apex of a reversed river-fan, at the east end of the Kielce hills, and it is probable that the upper Vistula was driven to join the San by the advancing ice-front of the Riss age, and that both rivers then escaped southwards. The joint waters were again held up when the Fennoscandian ice rested along the line marked by the Baltic Heights, and it is well known that a great river flowed westward along the stagnating ice-front where now the marshes of the Netze mark its course. As the ice-front shrank backward, towards the Baltic basin,[25] streams flowed down

[21] See especially H. W. Ahlmann, "Ragundasjöns Geomorfologoi," *Sveriges Geol. Undersök*, 1915; also Ahlmann, Carlzon, and Sandegren, "Quaternary History of the Ragunda Region, Jämtland," *Geol. Fören. Förhandl.*, vol. xxxiv. (1912), p. 343.

[22] Records Geol. Surv. India, vol. xxvii. (1894), p. 55, and NATURE, vol. l., p. 501.

[23] W. M. Davis, "Die erklärende Beschreibung der Landformen" (1912), p. 106.

[24] G. A. J. Cole, "The Growth of Europe" (1914), p. 109.

[25] R. Lepsius (*Geologie von Deutschland*, pt. 2, p. 511) urges that the sinking of the floor of northern Europe led to this northward trend of the streams.

over the sands and boulder-clays and cut their valley-heads back southward. Overflows may have taken place on the unconsolidated wall of the great east-and-west river, which was now deprived of its barrier of moraine-filled ice. In one way or another, the shallow valley of the main river was tapped near Kustrin, and the Oder, rising in the Moravian plateau, was sent northward as an independent stream. Similarly, the Vistula was carried off at Fordon, where the bend due to capture is conspicuous at the present day; and the whole drainage of the north wall of the Carpathians swept across the drift deposits down the course of some hitherto unimportant stream. Along the valley thus carved out, brown and yellow cliffs now rise above the marshy flood-plain, and the red castles of advancing Germany have for centuries looked down firmly on the stream. It is quite contrary to our customary philosophy, but a good corrective all the same, to ask ourselves if this lower valley of the Vistula, eighty miles in length, was shaped in a few months or a few years. The main part of the excavation, across unconsolidated lands, may have occupied less time than the building of the strongholds at the fords.

Conclusion.

In spite of the swamping of the Alkmaar country in 1825, in spite of the tragedy of Messina only seven short years ago, we feel that Europe is a settled continent, and we judge the past and future by the present superficial peace. We have applied the same thoughts to human movements, and the inconceivable has happened in our midst. We naturally find it difficult to carry our minds back to epochs when the earth-blocks may have parted asunder as ice parts across the polar seas. We have still, however, very much to learn about causes now in action; and the mystery of the earth, and of our connection with it, grows upon us as we learn. Can we at all realise the greatest change that ever came upon the globe, the moment when living matter appeared upon its surface, perhaps over a few square miles? Matter is either dead or living, that is, endowed with life; there is no intermediate state. And here was living matter, a product of the slime, if you will, but of a slime more glorious than the stars. Was this thing, life, a surface-concentration, a specialisation, of something that had previously permeated all matter, but had remained powerless because it was infinitely diffuse? Here you will perceive that the mere geologist is very much beyond his depth. Let us return to our orderly studies, our patient hammerings, our rock-slices, our chiselling out of fossil shells. Behind it all is the earth itself, quiescent, it may be, but by no means in the sleep of death. As Termier puts it, "La planète n'est pas encore morte; elle ne fait que dormir." If in this address I have dwelt upon the possibility of rapid changes in its surface, no member of our association will feel the least alarm.

Felix qui potuit rerum cognoscere causas,
Atque metus omnes, et inexorabile fatum
Subiecit pedibus, strepitumque Acherontis auari.

SECTION E.

GEOGRAPHY.

OPENING ADDRESS[1] BY MAJOR H. G. LYONS, D.Sc., F.R.S., PRESIDENT OF THE SECTION.

The Importance of Geographical Research.

THIS year, when the British Association is holding its meeting in times of the utmost gravity, the changed conditions which have been brought about by this war must occupy the attention of all the sections to a greater or less extent, and our attention is being called to many fields in which our activities have been less marked or more restricted than they might have been, and where more serious study is to be desired. The same introspection may be usefully exercised in geography, for although that branch of knowledge has undoubtedly advanced in a remarkable degree during the last few decades, we have certainly allowed some parts of the subject to receive inadequate attention as compared with others, and the necessity for more serious study of many of its problems is abundantly evident.

In order that we may see what advance has been made in the scientific study of geography in this country during the last quarter of a century, we must turn to the results that have been attained by the activity of geographical investigators who have devoted themselves to the serious study of various phenomena, and the detailed investigation of particular regions. If we do so I think we must admit that the number of original investigators in scientific geography who are extending its scope in this way is not so large as it might be, nor are we yet utilising sufficiently all the material which is available to us. Anyone who will examine the geographical material which has been published in any period which he may select for review will find that purely descriptive treatment still far outweighs the analytical treatment which alone can lead to definite advances in scientific geography. If pleasing descriptions of this or that locality are sought for, they are for the most part to be found readily in the very large amount of such material that has been and is being published each year by residents, travellers, and explorers; but if information is desired in the prosecution of a piece of geographical research, we are checked by the lack of precise details. Few descriptions of this class are sufficiently definite to enable the necessary comparisons to be made between one locality and others which are similarly situated; thoroughly quantitative treatment is for the most part lacking, and while a pleasing picture is drawn which is probably true in character, it is usually inadequately furnished with those definite facts which the geographer requires.

The opportunity to undertake long journeys through distant lands comes to few of us, but this is not the only direction in which research can be profitably undertaken, for there is no part of these islands where a geographer cannot find within his reach some geographical problem which is well worth working out, and which, if well and thoroughly done, will be a valuable contribution to his science. Even for such as cannot undertake such field work the library will provide a host of subjects which have not received nearly the amount of attention and of careful study that they deserve. The one thing essential is that the study should be as thorough as possible, so that all the contributory lines of evidence shall be brought together and compared, and so that the result may prove to be a real addition to geographical science on which other workers may in their turn build.

The ease with which a tract of country or a route can be described by the traveller, and the attractiveness of such a description of a little-known region, results in the provision of a vast quantity of geographical information, the greater part of which has probably been collected by those who have no adequate training in the subject. But anyone who has had occasion to make use of such material in a serious investigation is only too well aware how little precise and definite information he will be able to extract from the greater part of this wealth of material, and in most cases this is due to the traveller's lack of geographical knowledge. He probably does not know the pheno-

[1] Slightly abridged by the author.

mena which should be observed in the type of region which he is traversing, nor can he read the geographical evidence which lies patent to a trained observer at every point of the journey; much, therefore, of what he records may be of interest, but probably lacks data which are essential to the geographer if he is to understand the geographical character of the region, and utilise it properly.

Thus it happens that although the amount of geographical material which is being garnered may be large, the proportion of it which is available for use in a scientific investigation of an area is smaller than is probably realised by those who have not made the experiment. And yet it is only by this scientific investigation of selected localities or of a single phenomenon and by working them out as thoroughly as possible that any real advance in geographical science can be made. There should now be an ever-increasing number of geographers trained to proceed in their investigations by the true scientific method, and there should be a very considerable amount of sound work in various branches of the subject which aims at thoroughly investigating some phenomenon, or group of phenomena, so as to present a grouping of data, carefully verified and critically discussed, in order to arrive at conclusions which may form a useful addition, however small, to the sum of our geographical knowledge.

So far as I am able to judge, the output of serious work of this character is not nearly as large as it should be, and I would indicate some fields in which there is a lack of individual work of this character. Until more of it is undertaken we shall lack in this country the material from which the foundations of scientific geography can be built up, and while our own islands and the various parts of the British Empire furnish unrivalled opportunities for such work, there are still far too many subjects where the most thorough investigations have been made in other countries.

Mathematical geography presents a field for research which has had comparatively little attention paid to it in this country. In many respects this part of the subject is peculiarly suitable for such treatment, since it admits of the employment of precise methods to an extent which is not always practicable in cases where so many of the factors can only be approximately defined. The determination of positions on the earth's surface is carried to great refinement in the national surveys of most civilised countries in order to furnish the necessary controls for the preparation of large-scale maps, but when we pass to the location of travellers' routes, where considerable allowance has to be made for the conditions under which the observations have to be taken, we find that very inadequate attention is usually paid to the discussion of the results. Usually a mean value for each latitude, longitude, or azimuth is obtained by the computer, and he remains satisfied with this, so that when the route of another traveller follows the same line or crosses it at one or more points, it is almost impossible for the cartographer to say which of the two determinations of any position is entitled to the greater confidence. In this class of work, whether the results are obtained from absolute observations at certain points or from the direction of march, and the distance traversed, it is quite practicable to determine the range of uncertainty within which the positions of different points are laid down, and it is eminently desirable that this should always be done in order that the results of various routes which may intersect in partially known regions may be adjusted in accordance with definite mathematical processes. Some important expeditions on which infinite labour and considerable sums have been expended have presented their results, in so far as they relate to the routes which have been followed and the position of points which have been determined, in such a way that it is impossible to say with what precision such positions have been determined, and consequently any combination of these results with those of later expeditions has to be carried out empirically, since adequate data are no longer available for the employment of better and more scientific methods.

This crude and unsatisfactory way of treating observations, which in many cases have been obtained under conditions of the greatest difficulty and even hardship, is largely due to the lack of interest which geographers have shown in this part of their subject. Methods of observation and methods of computation are rarely discussed before any of our geographical societies or in any of our publications, and it is only by such discussions that the importance of properly working out the available material at a time when the observer can be consulted on points which are doubtful, or where further explanation is desirable, becomes generally appreciated.

No set of physical or astronomical observations is ever discussed or even presented without the degree of precision or trustworthiness being definitely stated; yet in geography this sound rule is too often neglected.

There are several regions where travellers' routes intersect which should provide ample material for the careful reduction and adjustment of the results. I fear, however, that there would be great difficulty in obtaining the original observations which are indispensable in such an investigation, and in the interest of research it is highly desirable that the original documents of all work of importance should be preserved and the place where they may be consulted should be recorded in the published account.

There is room in the geographical investigation of sea and land, even within the limits of the British Empire, for the employment of methods of observation and computation of the highest precision as well as of the simpler and more approximate kinds, but everyone who presents the results of his work should deem it his first duty to state explicitly the methods which he employed, and the accuracy to which he attained, in such a form that all who make use of them can judge for themselves of the degree of their trustworthiness.

In such work, while the instruments used are of great importance, too often the briefest description, such as "a 4-in. theodolite," is deemed sufficient. If the observer wishes his work to be treated seriously as a definite contribution to science we require to know more than this, and a clear account of the essentials of the instrument, a statement of its errors, and of the methods of observation adopted are the least that will suffice. The account of any expedition should treat so fully of the instruments, observations, and computations utilised to determine the positions of places visited that anyone can re-examine the evidence and form his opinion on the value of the results obtained. A mere tabular statement of accepted values, which frequently is all that is provided, is of small value from a scientific point of view. Probably one reason for this state of things is that too little attention is being paid by geographers to their instruments. Theodolites, levels, compasses, clinometers, tacheometers, plane-tables, pantographs, co-ordinatographs, planimeters, and the many other instruments which are used by the surveyor, the cartographer, the computer, have in no case arrived at a final state of perfection, but it is seldom that we find a critical description of an instrument in our journals.

Descriptions there are from time to time, but these are for the most part weak and insufficient. Not only is a technical description required, which treats fully of both the optical and mechanical details, but we need an extended series of observations with the instrument which have been made under the ordinary conditions of practical work, and these must be mathematically analysed, and the degree of the trustworthiness of the results clearly demonstrated. The description should be equally thorough and complete, including scale drawings showing the construction of the instrument as well as photographs of it. Nothing less than this is of any use to the scientific cartographer.

In this country the early advances of British instrument-makers of surveying instruments are far from being adequately represented in our national museum in a manner commensurate with their importance. The keen and enlightened zeal of geographers who are interested in this branch of the subject would doubtless quickly bring to light much still remaining that is of great interest, but which is yet unrecognised, while a closer attention to instrumental equipment would lead to improvements and advances in the types that are now employed. There is no modern work in this country on the development of such instruments, and references to their history are conspicuously rare in our journals, so that there is here an opportunity for those whose duties prevent them from undertaking travel or exploration of a more ambitious kind. In the same way, those whose opportunities of field work are few can find a promising field of study in the early methods and practice of surveying which have been discussed by many authors from classical times onwards, and for which a considerable amount of material exists.

In geodesy and surveying of high precision there is ample scope for all who are attracted by the mathematical aspect of the subject; the critical discussion of the instruments and methods employed and results obtained, both in this country and in other lands, provides opportunity for much work of real value, while its bearing upon geology, seismology, etc., has not yet been adequately treated here. The detailed history of this part of our subject is to be found in papers which have been published in the technical and scientific journals of other countries for the most part; here too little attention has been given to the subject, in spite of the large amount of geodetic work which has been executed in the British Empire, and which remains to be done in our Colonies and overseas Dominions.

The final expression of the surveyor's detailed measurements is found in the map, and the adequate representation of any land surface on a map-sheet is both a science and an art. Here we require additional work on all sides, for there is scarcely any branch of geography which offers so remunerative a field for activity as cartography. We need the cooperation of trained geographers to study requirements, and to make acquaintance with the limits of technical methods of reproduction, so that they may be in a position to deal with many questions which arise in the preparation of a map regarding the most suitable mode of presentation of data, a matter which is purely geographical, but which at the present time is too often left to the skilled draughtsman. Neither the compilation nor the reduction of maps is a merely mechanical process. The first requires great skill and care as well as technical knowledge and a sound method of treatment if the various pieces of work, which are brought together to make up the map of any considerable area, are to be utilised according to their true worth. This demands a competent knowledge of the work which has been previously done on the region, a first-hand acquaintance with the data collected by the earlier workers, and the critical examination of them in order that due weight may be given to the better material in the final result. This is not a task to be handed over to the draughtsman, who will mechanically incorporate the material as though it were all of equal accuracy, or will adjust discrepancies arbitrarily and not on any definite plan. Such preliminary preparation of cartographical material is a scientific operation which should be carried out by scientific methods and should be completed before the work reaches the draughtsman, who will then have but to introduce detail into a network of controls which has been prepared for him and of which the accuracy at all points has been definitely ascertained. Similarly in the second case the elimination of detail which must of necessity be omitted is an operation needing the greatest skill, a full understanding of the material available, and an adequate appreciation of the result which is being aimed at, such as is only to be found in a competent geographer who has made himself intimately acquainted with all the material which is available and has his critical faculty fully developed.

All these problems are well within the reach of the geographer to whom the opportunity of travel in other regions does not come, and in them he will find ready to his hand a field of research which is well worth working and which will amply repay any labour that is spent upon it. The same precise methods of investigation which are employed in the discussion of observations should be applied to all cartographic material in order to ascertain the exact standard of its trustworthiness, in which is included not only the correctness of distance and direction, but also the accuracy of the information which has been incorporated in it; and these may be brought to bear also on those early maps of which so many are preserved in our libraries in this country. In this field of study several investigators have already achieved results of great interest and value, but I think they will be ready to admit that there is here a wide and profitable field of activity for many more workers who will study closely these early maps and, not being contented with verbal descriptions, will use quantitative methods wherever these are possible.

In the study of map projections some activity has been visible in recent years, and we may hope that those who have worked in this branch of the subject will see that British geography is provided with a comprehensive manual of this subject which will be worthy of the vast importance of cartography to the Empire. The selection of suitable projections is receiving much more attention than was formerly accorded to it, but the numbers of communications on this subject which reach geographical journals are few and far between. The subject is not one which can appeal strongly to the amateur geographer, but its importance renders it imperative that the scientific geographer who realises its intimate bearing upon all his work should so arrange that the matter does not fall into the background on this account.

But it may be suggested that the lack of activity in mathematical geography is due to the somewhat specialised nature of the subject, and to the fact that the number of those who have received an adequate mathematical training and are prepared to devote themselves to geography is few. When we turn to physical geography in its treatment of the land we do find a field which has been more actively worked, for this is just the one to which the traveller's and explorer's observations should contribute most largely, and where therefore their material should be utilised

with the best results. Even here there is room for much more work of the detailed and critical type, which is not merely general and descriptive, but starts from the careful collection of data, proceeds to the critical discussion of them, and continues by a comparison of the results with those obtained in similar observations in other regions.

To take a single branch of physical geography, the study of rivers, the amount of accurate material which has been adequately discussed is small. In our own country the rainfall of various river basins is well known through the efforts of a meteorological association, but the proportion of it which is removed by evaporation, and of that which passes into the soil, has only been very partially studied. Passing to the run-off, which is more easy to determine satisfactorily, the carefully measured discharges of streams and rivers are not nearly so numerous as they should be if the hydrography of the rivers is to be adequately discussed; for although the more important rivers have been gauged by the authorities responsible for them in many cases, the results have usually been filed, and the information which has been published is usually a final value, but without either the original data from which it has been deduced, or a full account given of the methods of measurement which have been employed. For the requirements of the authority concerned such a record is no doubt adequate, but the geographer requires the more detailed information if he is to co-ordinate satisfactorily the volume discharged with local rainfall, with changes in the rates of erosion or deposition, and the many other phenomena which make up the life-history of a river. Here, too, it is usually only the main stream which has been investigated; the tributaries still await a similar and even fuller study.

In the same way we still know too little of the amounts of the dissolved and suspended matter which is carried down by our streams at various seasons of the year and in the different parts of their course.

In this one branch of the subject there is ample scope for workers of all interests in the measurement of discharges, in the determination of level, and of the movement of flood waves, in determining the amount of matter transported both in suspension and in solution, in tracing out the changes of the river channel, in following out the variation of the water-table which feeds the stream, in ascertaining the loss of water by seepage in various parts of its course, and generally in studying the hundred other phenomena which are well worth investigating, and which give ample scope for workers of all kinds and of all opportunities. There is work not only in the field, but also in the laboratory and in the library which needs doing, for the full account of even a single stream can only be prepared when data of all classes have been collected and discussed.

On the Scottish lakes much valuable scientific work has been done, and also on some of the English lakes, so that excellent examples of how such work should be done are available as a guide to anyone who will devote his spare time for a year or two in making a thorough acquaintance with the characteristics and phenomena of any lake to which he has access.

Coast-lines provide another class of geographical control which repays detailed study, and presents numberless opportunities for systematic investigation and material for many profitable studies in geography. The shores of these islands include almost every variety of type, and furnish exceptional opportunities for research of a profitable character, especially as lying on the border-line between the domain of the oceanographer on one hand and the physiographer on the other. The precise methods of representation which are possible on the land have to give way to a more generalised treatment over the sea, and the shore line is liable to be handed over to the latter sphere, so that there is much interesting and useful work open to anyone who will make an accurate and detailed study of a selected piece of coast-line, co-ordinating it with the phenomena of the land and sea respectively.

The teaching of Prof. Davis in pressing for the employment of systematic methods in describing the landscapes with which the geographer has to deal has brought about a more rational treatment, in which due recognition is given to the structure of the area, and the processes which have moulded it, so that land forms are now for the most part described more or less adequately in terms which are familiar to all geographers and which convey definite associated ideas, in the light of which the particular description is adequately appreciated. It has been urged by some that such technical terms are unnecessary and serve to render the writings in which they occur intelligible only to the few; that anyone should be able to express his meaning in words and sentences which will convey his meaning to all. There is no great difficulty in doing this, but in such descriptions to convey all that a technically-worded account can give to those who understand its terms would be long and involved on account of the numerous related facts which would be included. It is consequently essential in all accurate work that certain terms should have very definite and restricted meanings, and such technical terms, when suitably chosen, are not only convenient in that they avoid circumlocution, but when used in the accepted sense at once suggest to the mind a whole series of related and dependent conditions which are always associated with it.

The crystallisation of such geographical terms into true technical terms is an important step in the furtherance of scientific geography, but it must be done by the geographers themselves, and no means of doing this is more fruitful than the work of original research and investigation in definite areas or on specific problems.

If we now consider some of the problems of human geography we shall find the need for such systematic study to be even greater; for the variable factors involved are more numerous than in physical geography, and many of them are difficult to reduce to precise statement; the quantitative study of the subject is therefore much more difficult than the qualitative or descriptive, so that the latter is too frequently adopted to the exclusion of the former. The remedy lies, I believe, in individual research into special cases and special areas where the factors involved are not too numerous, where some of them at least can be defined with some accuracy, and where, consequently, deductions can be drawn with some precision and with an accuracy which gives grounds for confidence in the result. The settlements of man, his occupations, his movements in their geographical relations are manifested everywhere, and subjects of study are to be found without difficulty, but their investigation must be based on actual observation, and on data which have been carefully collected and critically examined, so that the subject may be treated as completely as possible, and in such a way that the evidence is laid before the reader in order that he may form his own conclusions.

It is probable that some of the lack of precision which is to be found in this part of the subject is to be attributed to the want of precision in its terminology. For many things in human geography good technical terms are required, but these must be selected by those who have studied the type of phenomenon concerned and have a clear idea of the particular conditions which they desire to associate with the term;

this is not the work of a committee of selection, but must grow out of the needs of the individual workers.

There is, it must be admitted, no small difficulty in using the same preciseness of method in this portion of the subject as is readily attainable in mathematical geography, and is usually practicable in physiography; but at any rate it is undesirable to indicate any condition as the controlling one until all other possible influences have been carefully examined, and have been shown to have less weight than that one which has been selected.

Whether the investigation deals with the settlements of man or his movements and means of communication, it is important that in the first instance problems of a manageable size should be undertaken and thoroughly treated, leaving larger areas and wider generalisations until a sufficient stock of thoroughly trustworthy material which is in the form in which it can properly be used for wider aims is available.

The relation of geographical conditions to small settlements can be satisfactorily worked out if sufficient trouble is taken and all possible sources of information, both of present date and of periods which have passed away, are utilised. Such studies are of a real value and pave the way to more elaborate studies, but we need more serious study of these simpler cases both to set our facts in order and to provide a methodical classification of the conditions which prevail in this part of the subject. Out of such studies there will grow such a series of terms with well-defined associations as will give a real precision to the subject which it seems at the present time to lack.

The same benefit is to be anticipated from detailed work in relation to man's communications and the interchange of commodities in all their varied relations. Generalised and descriptive accounts are readily to be found, and these are for the most part supported by tables of statistics, all of which have their value and present truths of great importance in geography, but the spirit of active research which aims at clearing up thoroughly a small portion of the wide field of geographical activities has unequalled opportunities in the somewhat shadowy relations between the phenomena which we meet in this part of the subject, for focusing the facts better, and obtaining a more exact view of the questions involved.

Where the geography of States (political geography) is concerned the same need for original investigation as a basis for generalisations may be seen. At the present time there is much said about the various boundaries of States, and in general terms the advantages and disadvantages of different boundaries under varied conditions can be stated with fair approximation to accuracy. But I do not know of many detailed examinations of these boundaries or portions of them where full information of all the factors involved can be found set out in an orderly and authoritative manner, thus forming a sure foundation for the generalised description and providing the means of verifying its correctness or revising it where necessary.

Perhaps there is really more scientific research in geography being undertaken by individuals than I have given credit for, but certainly in geographical periodicals, and in the bibliographies which are published annually, the amount shown is not large; neither is the number of authors as large as might be expected from the importance and interest of the subject and from the activity of those centres where geography is seriously taught. There seems to be no reason why individual research on true scientific lines should not be as active in geography as it is in geology, botany, zoology, or any other branch of knowledge; and, just as in these, the real advance in the subject is dependent on such investigations rather than on travels and explorations in little-known lands, unless these, too, are carried out scientifically and by thoroughly trained observers who know the problems which there await solution, and can read the evidence which lies before them on their route.

If research in these directions is being actively prosecuted, but the appearance of its results is delayed, let us seek out the retarding causes, if there be any, and increase any facilities that may be desirable to assist individual efforts.

Short technical papers of a thoroughly scientific character, such as are the outcome of serious individual research, are, of course, not suitable for those meetings of geographical societies where the majority of the fellows present are not scientific geographers, but should be presented to small meetings of other workers in the same or allied fields, where they can be completely criticised. The reading, discussion, and the publication of papers of this class are for geography a great desideratum, for it is in them and by them that all real advance in the subject is made, rather than by tales of travel, however interesting, if these are not the work of one trained in the subject, having a knowledge of what he should observe, and of what his predecessors have done in the same field. The regional aspect of geography in the hands of its best exponents has given to young geographers a wide and comprehensive outlook on the interaction of the various geographical factors in a region, the responses between the earth's surface and the life upon it, and the control that one factor may exercise upon another. In this form the fascination of geographical study is apparent to everyone, but I sometimes wonder whether the exposition of such a regional study by one who is thoroughly master of the component factors, having a first-hand knowledge of all the material involved, and knowing exactly the trustworthiness of each portion, impresses sufficiently upon the student the necessity of personal research into the details of some problem or phenomenon in such a way as to gain a real working acquaintance with them; or does it, on the other hand, tend to encourage generalisations based on descriptive accounts which have not been verified, and where coincidences and similarities may be accepted without further inquiry as evidence of a causal connection which may not really exist? I imagine that the student may be attracted by the apparent simplicity of a masterly account of the geographical contents and responses involved, and may fail to realise that geographical descriptions, even though technically phrased, are not the equivalent of original quantitative investigation, either for his own education or as a contribution to the subject.

For these reasons I believe that societies can do far more good in the promotion of geography as a science by assisting competent investigators, by the loan of books and instruments, and by giving facilities for the discussion and publication of technical papers, than by undertaking the investigation of problems themselves.

Among the earlier presidential addresses of this section some have laid stress on the importance of the recognition by the State of geography in education; others have represented the great part which the geographical societies have played in supporting and advancing the subject; others again have urged the fuller recognition of geography by educational institutions. I would on this occasion attach especial importance to the prosecution of serious research by individuals in any branch of the subject that is accessible to them, to the discussion of the results of such work by others of like interests, and to the publication of such studies as having a real value in promoting the advancement of scientific geography.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

LONDON.—Mr. H. G. Plimmer, F.R.S., has been appointed professor of comparative pathology in the Royal College of Science, South Kensington.

FOUR lectures will be delivered at Gresham College, E.C., on "Typhus Fever and Cerebrospinal Meningitis," on October 5–8, by Dr. F. M. Sandwith, Gresham Professor of Physic. The lectures are free to the public, and will begin each evening at six o'clock.

A SERIES of lectures on "The Wonder-workers of the Soil" will be given in the fellows' rooms of the Royal Botanic Society of London, Regent's Park, N.W., on October 4, 11, and 18, by Prof. W. B. Bottomley. The lectures will deal with:—(1) soil bacteria in relation to soil fertility; (2) the story of soil inoculation; (3) the discovery of auximones (accessory food substances).

BY the will of Mr. W. Jackson, engineer, of Aberdeen, who left, in addition to real estate, personal estate in the United Kingdom valued at 77,052*l*., one-half of the ultimate residue of his property, which is subject to his wife's life interest, is left for the establishment of a chair of engineering in the University of Aberdeen, any balance being then applied for charitable or benevolent objects in Aberdeen.

THE Manchester Municipal School of Technology publishes separate prospectuses of its part-time courses, and those in chemistry and chemical technology and in mathematics, physics and natural science, have been received. The part-time courses include:—apprentices' day courses for engineers' and other apprentices whose employers allow them to devote one whole day per week to study; evening courses, involving attendance on three evenings a week for five years, and leading to the Associateship of the School of Technology; and other evening and part-time day classes for advanced study and research, in preparation for the external degrees of the University of London, in technological or trade subjects, in various branches of natural science, and in other subjects. Further particulars of the work of the college were given in NATURE for August 12 last (vol. xcv., p. 664).

THE new session of the Sir John Cass Technical Institute, Aldgate, E.C., which is especially devoted to technical training in chemistry, metallurgy, and physics, and in the artistic crafts, will commence on September 27th. The instruction in experimental science provides systematic courses for London University examinations in addition to the courses on higher technological instruction, which form a special feature of the work of the Institute. The curriculum in connection with the fermentation industries includes courses of instruction on "Brewing and Malting" and on the "Micro-Biology of the Fermentation Industries." A series of lectures dealing with the supply and control of power has been arranged. These will comprise lectures on "The Supply and Control of Liquid, Gaseous, and Solid Fuel," "Electrical Supply and Control," and "The Transmission of Power." In the department of physics a special course will be given on "Colloids," which will deal with the methods employed in their investigation and their relation to technical problems; also special lectures on "The Influence of Surface Tension on Chemical Phenomena." In the metallurgy department special advanced courses are provided on gold, silver, and allied metals, iron and steel, metallography and pyrometry, heat treatment of metals and alloys, and mechanical testing of metals and alloys.

THE calendar for the current session has reached us from the Merchant Venturers' Technical College, Bristol, in which the Faculty of Engineering of the University of Bristol is provided and maintained. The college aims at providing a sound, continuous, and complete preparation for an industrial career, and its work is carried out in a secondary school, in day classes, and in evening classes. The calendar gives much evidence of the success of the governors of the college in securing the co-operation and support of the employers of the district. Many engineering firms have expressed willingness, other things being equal, to give preference to students who have completed the full college course, and some are prepared to take students at reduced premiums, while others will waive premiums altogether. Many local employers exempt from overtime, on not more than three days a week, persons in their employ who attend the college evening classes. A list of such persons is sent to each firm at the beginning of the session, with a list of the nights on which they ought to attend the classes; and a monthly return of the attendances of the evening students belonging to each firm is also forwarded. The Board of Trade accepts attendance at the evening classes in engineering in lieu of a portion of the workshop service required from candidates for the Board's certificate of competency as engineer. In other ways, too, such as by gifts and loans of books and plant, the employers of labour are showing a growing interest in the useful and varied work of this important technical college.

SOCIETIES AND ACADEMIES.

LONDON.

Geological Society, June 23.—Dr. A. Smith Woodward, F.R.S., president, in the chair.—Prof. Xavier **Stainier**: A new eurypterid from the Belgian Coal Measures. The discovery is recorded of a specimen of a new Eurypterus in the cores of a trial-boring for coal in Belgium. The fossil, which is in a satisfactory state of preservation, is described. A short description of the eleven Carboniferous species known up to the present is appended. The nearest form to the Belgian fossil seems to be a Pennsylvanian Eurypterus, which, nevertheless, is not identical with the former. The geological range and the evolution in time of the twelve Carboniferous eurypterids is discussed.—R. B. **Newton**: A fossiliferous limestone from the North Sea. The material was trawled from the floor of the North Sea. It presents no appearance of glaciation, so that its occurrence *in situ* seems to be highly probable. There is no record of a similar limestone from either England or Scotland. It is of highly siliceous character and full of marine shells, of which the Pelecypoda are the more prominent; there are fragments of wood in contact with the limestone which appear to show coniferous characters. Some twenty-three species of mollusca have been determined, all of which exhibit a southern facies, including a new dosiniform shell belonging to the genus Sinodia, the relationships of which are confined to the Indian Ocean regions of Southern Asia. Eighteen of the species trace their origin from the Vindobonian stage of the Miocene, ten may be regarded as extinct, whereas twelve still exist in recent seas. The majority of the species are fairly evenly distributed in both the Coralline and the Red Crag formations of East Anglia, although it is thought that the rock must be of older age than Red Crag. Additional support is given to this view, because such shells as *Arcoperna sericea*, *Tellina benedeni*, and *Panopaea menardi* are not known of later age in this country than the Coralline Crag. The occurrence also of extinct

gastropods, which are characteristic of the Upper Miocene or Messinian deposits of northern Germany, constitutes further evidence in favour of a greater antiquity for this limestone than that of the Red Crag; it is, therefore, considered to be of Coralline Crag age.—W. R. **Jones**: The origin of the tin-ore deposits of the Kinta district, Perak (Federated Malay States). Certain tin-ore-bearing clays occurring in the Kinta district have been described as being of glacial origin, and the tin-ore which they contain as having been derived from "some mass of tin-bearing granite and rocks altered by it, distinct from and older than the Mesozoic Granite" (that is, than the granite now *in situ* in the Kinta district). These clays are stated to have furnished a more valuable horizon on climatic evidence than can be afforded by limited collections of fossils in rocks far removed from Europe. The importance is urged of the origin of these clays in a country where, on one hand, they yield an important part of the world's output of tin-ore, and where, on the other, they have been used as the horizon on which to base the geological age of rocks which cover about a third of the surface of the Malay Peninsula. If of glacial origin, a vast tin-field remains to be discovered. The object is to show that all the tin-ore found in these clays is derived from rocks now *in situ* in the Kinta district; that it is not necessary to bring in glacial action to explain and to show that a simple interpretation may be given to the geology of the Kinta district. The sources of the tin-ore are:—(1) the stanniferous granite of the Main Range; (2) other granite outcrops known to carry cassiterite; (3) the granitic intrusions in the phyllites and schists; and (4) the granitic intrusions traversing the limestone. The angularity of the boulders and of the tin ore in some of these clays is due (1) to weathering *in situ* of the phyllites and schists, which then sink on the dissolving limestone underneath; (2) to soil-creep effecting the same result; (3) to the breaking up of the weathered cassiterite-bearing boulders in the alluvium. More than 90 per cent. of the ore worked in the Kinta district is obtained from mines situated at less than a mile from granite or from granitic intrusions.

BOOKS RECEIVED.

Tables for Converting Shillings, Pence, and Farthings into 7 Places of Decimals of a Pound; and for the re-Conversion of Decimals. Pp. 8. (London: C. and E. Layton.) 1s. net.

Memoirs of the Indian Museum. Vol. v., No. 1. Fauna of the Chilka Lake. By N. Annandale and S. Kemp. Pp. iii+146+x plates. (Calcutta: Indian Museum.) 15 rupees.

A First Book of Arithmetic. By S. Lister. Pp. vii+258. (London: Macmillan and Co., Ltd.) 1s. 6d.

Alcohol and the Human Body. By Sir V. Horsley and Dr. M. D. Sturge. Fifth edition, enlarged. Pp. xxviii+339. (London: Macmillan and Co., Ltd.) 1s. net.

Science of Dairying. By W. A. G. Penlington. Pp. viii+260. (London: Macmillan and Co., Ltd.) 2s. 6d.

Laboratory Exercises, arranged to accompany "First Course in Chemistry." By Profs. W. McPherson and W. E. Henderson. Pp. x+128. (Boston and London: Ginn and Co.) 2s.

The Essentials of Agriculture. By W. J. Waters. Pp. x+455+xxxvi. (Boston and London: Ginn and Co.) 5s. 6d.

Diversions of a Naturalist. By Sir Ray Lankester. Pp. xvi+424. (London: Methuen and Co., Ltd.) 6s.

A Concise Kaffir-English Dictionary. By J. McLaren. Pp. xv+194. (London: Longmans and Co.) 3s. 6d.

A Manual of Pharmacology. By Prof. W. E. Dixon. Fourth edition. Pp. xii+467. (London: E. Arnold.) 15s. net.

On the Prevention of "Frost-bite" and other Effects of Cold. By S. Delépine. Pp. 32. (London: John Bale, Ltd.)

Some Aspects of Industrial Chemistry. By Dr. L. H. Baekeland. Pp. 43. (New York: Columbia University Press; London: Oxford University Press.) 1s. 6d. net.

Dove Marine Laboratory, Cullercoats, Northumberland. Report for the Year ending June 30, 1915. Edited by Prof. A. Meek. Pp. 59. (Newcastle-on-Tyne: Cail and Sons.) 5s.

Tychonis Brahe Dani Opera Omnia. Edidit I. L. E. Dreyer. Tomus II. Pp. 461. (Hauniæ: Libraria Gyldendaliana.)

John Dalton's Lectures and Lecture Illustrations. Parts i. and ii. By Prof. W. W. H. Gee. Part iii. By Dr. H. F. Coward and Dr. A. Harden. Pp. 66. (Manchester: 36 George Street.) 1s. 6d.

West of Scotland Agricultural College, Glasgow. Calendar for Session 1915–16. Pp. 242. (Glasgow: The College.)

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THURSDAY, SEPTEMBER 30, 1915.

ENGINEERING MATERIALS.

(1) *Materials of Construction: Their Manufacture, Properties, and Uses.* By Prof. A. P. Mills. Pp. xxi+682. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1915.) Price 19*s*. net.

(2) *The Strength of Materials: A Text-book for Engineers and Architects.* By E. S. Andrews. Pp. x+604. (London: Chapman and Hall, Ltd., 1915.) Price 10*s*. 6*d*. net.

(1) "MATERIALS of Construction," by Mr. A. P. Mills, is an excellent text-book covering a wide field, including cementing materials, masonry, bricks and clay products, ferrous and non-ferrous metals and timber. Generally a short historical statement is given, a list of applications in the arts, a well-illustrated description of manufacturing processes, an account of chemical, physical, and mechanical properties, and some statistics of American production. The information is based largely, but not exclusively, on American experience, but is not less interesting on that account. English readers will be glad to become acquainted with the very trustworthy results of tests obtained by the U.S. Bureau of Standards, the Structural Materials Laboratory of the U.S. Geological Survey, and the laboratory of the U.S. Forest Service, as well as the investigations of the active American Society for Testing Materials.

The treatise is very comprehensive. For instance, in treating cements, there are separate chapters on gypsum plasters, quicklime, hydrated and hydraulic limes, Puzzolan and slag cements, natural cements, Portland cement and concrete. Or again, in dealing with ferrous metals, chapters on pig iron, cast iron, malleable cast iron, wrought iron, steel, and the special alloy steels. There is adequate criticism of the processes, the tests, and the investigations described.

Only a few points of interest can be referred to. The researches of Le Chatelier, Törnebohm, and the Newberrys on the constitution of Portland cement are carefully summarised, and the chemical, optical, and thermal researches at the Carnegie Geophysical Laboratory at Washington, which on the whole confirm the results of Le Chatelier. Standard American tests for cement are given and the conditions influencing the results are discussed. Curiously, rather little is said of methods of testing. The diagrams of tensile strength of 1 : 2, 1 : 3, and 1 :4 cement mortars with sand graded to different fineness are instructive, and a constant relation of density and strength was observed. Diagrams of the ratio of compressive to tensile strength, based on an extensive series of tests of neat cement and cement mortars made for the U.S. Geological Survey, are interesting.

It appears that charcoal is used in the production of about 1 per cent. of pig iron in the United States. A brief account is given of electric furnaces, the product of which is claimed to equal in quality Swedish charcoal iron. It is stated that the electric furnace used for steel-making has already become a formidable rival of the crucible process, because it is able to make larger tonnages of tool steel of crucible quality at lower cost. It has also advantages in the production of alloy steels in that it need not be operated under oxydising conditions.

The mechanical properties of materials are shown by numerous graphic diagrams, which condense in small space a large mass of results. It is interesting that the U.S. standard specifications for iron and steel express the elongation per cent. in the form constant/(ultimate tensile strength). This is the adoption of the Tetmajer coefficient of quality in commercial testing. The deviation of this rule from the results of tests, which is not inconsiderable, is shown in Fig. 263. Prof. Hatt's results on the ratio of elongation and work of rupture in static and dynamic tests will be new to most English engineers. The treatment of fatigue is imperfect.

(2) "Strength of Materials" is properly understood to relate to the methods and results of the experimental investigation of the physical constants of materials of construction and the testing of the quality of supplies from different sources. It touches, on one side, the mathematical theory of elasticity, and on the other, applications in the theories of machines and structures. In the volume by Mr. Andrews all these branches of applied mechanics are treated together, and strength of materials in the restricted sense is rather perfunctorily dealt with. Riveted joints, beams, struts, shafts, flat plates, and rotating discs are discussed mainly from a purely mathematical point of view, graphic methods being largely employed.

No doubt the book will be useful to students and young engineers, especially because so many special cases are worked out algebraically and numerically in detail. At the same time it is doubtful if the author has quite digested his reading. On some fundamental points he is obscure. Discrepant solutions are placed side by side, and the student left to his own resources or put off with "we believe." Thus two theories are given of the simple case of a rectangular reinforced beam. In a numerical example the bending moment comes out three times as great by one as

F

by the other. The calculation of deflections by "Mohr's method" is good. But the whole subject would have been much clearer if the well-known principle had been explained, that the load, shearing force, bending moment, slope and deflection curves form a series each derived from the next by graphic integration.

The phrasing is often loose. "For most metals . . . the yield point is reached when there is a sudden large increase in strain." Only in a few metals is there a yield point in this sense. The whole account of fatigue is unsatisfactory. The author is in confusion between the old view of Claxton Fidler, who must always be spoken of with respect, who believed that the Wöhler effect was purely the result of dynamic action, and what is now clear that there is a real "fatigue" due to slip fissures developing at first slowly, but at last rapidly and locally. It is true that American engineers have mixed up an allowance for fatigue and for impact in the case of railway bridges. But that is wrong in principle. Strictly, the fatigue allowance is not one of the factors which make up the factor of safety, but like the yield point, the fatigue limit is a stress not to be exceeded when the total stress due to load, impact, and contingencies has been calculated. To the author "the subject is still full of difficulties" (p. 89). At this late date it is odd to read "we will make the following assumptions in developing *our* theory of torsion" (p. 317). The use of alignment charts in designing springs seems new (p. 342).

PLANTS OF FORMOSA AND THE RIVIERA.

(1) *Icones Plantarum Formosanarum nec non et Contributiones ad Floram Formosanam.* Vol. iv. By B. Hayata. Pp. vi + 264 + xxv plates. (Taihoku: Government of Formosa, 1914.) n.p.

(2) *Flowering Plants of the Riviera.* By H. Stuart Thompson. With an Introduction on Riviera Vegetation. By A. G. Tansley. Pp. xxix + 249. (London: Longmans, Green, and Co., 1914.) Price 10*s.* 6*d.* net.

(1) THE fourth volume of Dr. Hayata's great work on the flora of Formosa, modestly described as "materials for a flora of the island," based on a study of the collections of the Botanical Survey of the Government of Formosa, contains descriptions of 285 species, of which no fewer than 167 are new to science, including a new orchid genus Arisanorchis of considerable interest as adding another member to the small list of leafless saprophytes in this family. Moreover, thirteen genera are mentioned as new to the Formosan flora, these including such well-known genera as Aconitum, Cornus, and Hydrocharis. This volume brings the total number of species of the flora up to more than 3000, and we are promised several more volumes, indicating the remarkable floristic richness of the island.

In his interesting introduction the author suggests two resolutions regarding the description of new species of plants for consideration at the meeting of the International Botanical Congress fixed for the summer of 1915 in London, "if the present overwhelming war is then over." This introduction is dated August 31, 1914. As usual in Dr. Hayata's works, the illustrations are numerous and beautifully executed, and the whole reflects the greatest credit upon the author and upon the enlightened Government of Japan. It is worthy of note that the author has preferred to follow the classification of Bentham and Hooker rather than that of Engler and Prantl, and this appears a wise choice, for although the former system may be in various respects inferior as a method of presenting the genetic affinities of the families of plants, the latter is far from being a natural system, and is constantly undergoing modification. This being the case, adherence to the older system, for purposes of ready comparison between different floras, is perhaps on the whole the best course to adopt.

(2) The author's previous volumes on alpine and subalpine plants fully demonstrated his facility for popular yet accurate plant description, and he has had long personal acquaintance with the region here dealt with. The flora is arranged on the Bentham and Hooker system, thus facilitating comparison with French works on the flora of the Riviera, in which the system used is practically identical with the English one. The author has spared no pains to make it easy for those with even a slight knowledge of botanical terminology to identify the plants described, for the actual descriptive part is preceded by synopses of family characters and keys to the tribes and genera, and there is also a full and clear glossary of terms used. As the subtitle ("A Descriptive Account of 1800 of the More Interesting Species") indicates, the book does not profess to be an exhaustive "flora," but though the botanist may regret the incompleteness which is particularly noticeable in the case of some of the larger families and genera, these cases nearly all refer to groups which the non-professional botanist would find unattractive. The author wisely refrains from the attempt, which mars many books of this scope, to manufacture so-called English names for species.

The plates, both coloured and plain, are exceedingly good, and a valuable feature of the book is the interesting but disappointingly brief introduction by Mr. Tansley, which deals with the ecology

of the Mediterranean vegetation and the various plant communities represented in the Riviera. However, brief as it is, this introduction gives a remarkably clear picture of the vegetation, such points as the relations of soils and the striking effects of exposure and shelter being well brought out. Those who hope to visit or revisit this beautiful region, when happier times arrive, should have Mr. Thompson's book on Riviera flowering plants.

TWO HANDBOOKS OF EXPLORATION.

(1) *Stories of Exploration and Discovery.* By A. B. Archer. Pp. x + 198. (Cambridge: At the University Press, 1915.) Price 2*s.* 6*d.* net.

(2) *The North-West and North-East Passages, 1576–1611.* Edited by P. F. Alexander. Pp. xx + 211. (Cambridge: At the University Press, 1915.) Price 2*s.* 6*d.* net.

(1) MR. ARCHER'S book supplies a short history of exploration in simple language. It opens perhaps a little uncertainly on the importance of the Eastern Mediterranean as the earliest known centre from which knowledge of the world was extended outwards. "The Egyptians used boats on the Nile, and perhaps along the coasts of their country, but probably the first serious navigators were the people of Phœnicia"—this, in the light of recent research concerning early Mediterranean peoples, is not a wholly satisfactory summary. The subsequent chapters are handled more firmly, and the rather difficult task of balancing between topographical correlation and historical sequence is judiciously carried out. The final chapters on modern polar exploration, however, are less successful. They maintain the interest to the student, but sometimes a point is missed: thus, it is an unfortunate version of the dramatic encounter between Nansen and Jackson which states that Nansen and Johansen "reached the south of Franz Joseph Land, where to their delight a relief ship was waiting." There is a short bibliography of easily-accessible books of reference, and a good index is provided. There are also some rough but sufficiently clear maps, and some clever adaptations of old maps.

(2) Mr. Alexander's book contains a series of extracts from original narratives of voyages in search of the north-west and north-east passages, together with an explanatory introduction, a chronology of important dates in geographical discovery generally, and notes. The extracts are from George Best's account of Frobisher's first and second voyages, from the narratives of Davis's three voyages and of Hudson's last voyage, and from de Veer's account of Barents's third voyage; which is supplemented by an account of the discovery, in modern times, of relics of that voyage. Hakluyt, Purchas, and the Hakluyt Society's second edition of Phillip's translation of de Veer have been drawn upon. The modernising of these texts, so far as necessary, has been carried out without any of the charm of the original being lost. It is this peculiar charm which makes these narratives most attractive to the student for whom these volumes are designed—for it should be added that this book belongs to a series to be known as "Cambridge Travel Books," of which another, "The Earliest Voyages Round the World," is stated to be in the press. The book is excellently produced, and the original illustrations reproduced are as instructive as they are amusing; there are also a few explanatory maps. It can only be a question whether in a book of this compass, designed for the purposes indicated, there should not be shorter extracts from more narratives, but no doubt it would be difficult, if not impossible, to carry out such a plan and maintain the interest of the originals.

OUR BOOKSHELF.

Aids to the Analysis and Assay of Ores, Metals, Fuels, etc. By J. J. Morgan. 2nd edition. Pp. viii + 138. (London: Baillière, Tindall and Cox, 1915.) Price, cloth, 3*s.* net; paper, 2*s.* 6*d.* net.

THE first edition of this capital little book has been useful to students of evening classes for a number of years, and the appearance of the second edition will be welcome to their instructors in metallurgical analysis. The general arrangement is good, and has been maintained unchanged, but the book has been considerably enlarged. In addition to descriptions of the assay of the ores of the common metals and of the complete analysis of commercially impure metals, sections are devoted to special steels and other alloys, fuels, furnace materials, and slags. There is also some account of the analysis of the by-products of coke-ovens. The characteristic of the book is that as a rule only one method of determination is given in each case, but the methods are well chosen as having stood the test of time, and the descriptions are concise and accurate. Little is said about apparatus and reagents; there are few illustrations, and in general the book seems to be intended rather to remind students of what they have been taught than to take the place of laboratory demonstration. In cases where the more expensive standard works on analysis and assaying are inaccessible, this handy volume will be found to take their place with scarcely any disadvantage. It is small enough to slip into the pocket.

Alignment Charts: their Principle and Application to Engineering Formulae. By E. S. Andrews. Pp. 32. (London: Published for James Selwyn and Co. by Chapman and Hall, Ltd.) 1*s.* 3*d.* net.

ALIGNMENT charts have been used to some extent by engineers in recent years, and are capable of being employed to a much greater extent. The

method was developed very largely by Prof. Peddle, of the Rose Polytechnic Institute, U.S.A., and his method of treatment has been followed by the author of the little book before us, with some variation in details. In this system of plotting scales of the variables involved are set off along parallel lines, and a straight-edge laid across the lines enables one of the variables to be determined when the others are given. The author describes methods to be followed when there are three, four, or more variables, and gives illustrations of the plotting of reinforced concrete column, boiler shell, steel beams, shafts, and other engineering formulæ.

Most of the illustrations are clear and easy to read; Figs. 1 and 2 are exceptions, the lettering and printing being poorly executed. There are very many problems of a repetition character in engineering, and much time can be saved by charts of this kind. There is also less risk of error in the results, once the chart has been correctly drawn. We can commend the book to engineers who wish to make themselves acquainted with this labour-saving device.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Mathematical Printing.

YOUR remarks in NATURE (September 16, p. 79) relating to the important suggestions on mathematical printing recently circulated by the London Mathematical Society, are confined to the examination of special points, in the light partly of application to the special case of an analytical memoir on dynamics of aeroplanes.

It is worth while to direct special attention to what is perhaps the main recommendation, for examples of its disregard are still conspicuous. The introduction of the notation of the solidus or oblique bar for fractions has had much to answer for, especially in this country, on account of its use in excess—for example, in reducing long formulas to the deal-level of a single line, thus obscuring their structure without any compensating gain. As originally revived by Sir George Stokes, and largely adopted on his suggestion, the intention was to render possible the printing of brief expressions isolated in the current text or elsewhere, without disturbing the line; its use for reducing a formula already specially set out, and involving a sum of fractions, to a single line of type, is usually to be deprecated.

The suggestion to replace the dot over a letter, the Newtonian symbol of its fluxion, by an accent following it, was put forward, doubtless with regret, as the lesser evil. If only printers would provide special types with the dot attached for the small number of letters likely to be thus affected, no change would be necessary.

JOSEPH LARMOR.

Cambridge, September 24.

Palæolithic Man in South Africa.

I HAVE read in NATURE of August 5, just received, Mr. F. W. Fitzsimons's letter referring to the discovery of Palæolithic man in South Africa. I would not trouble you with these lines were it not that many of its statements are erroneous. Moreover, owing to my name being mentioned in connection with a detailed examination which is being carried out in this museum, it might be thought that I am in part responsible for the conclusions which Mr. Fitzsimons enumerates. As a matter of fact, I informed him, when first the skull was sent to us, and again some nine months ago, that the fragment was not referable to the Neanderthal type. There is, therefore, no more justification in the statement he makes that there is "a close resemblance in shape, thickness, and measurements" of the Boskop to the Neanderthal than in his generalisation on the origin of the Palæolithic implements in South Africa, or in the state of mineralisation of the relic—"The skull is as completely fossilised as the Karoo fossil reptiles," which are Permian and Triassic.

The result of a preliminary investigation of the skull by our palæontologist will be read shortly before the Royal Society of South Africa. Until then I cannot give any details beyond referring those interested in the subject to a short note by Prof. Boule in *L'Anthropologie* (vol. xxv., September–December, 1914, p. 595).

L. PERINGUEY.

South African Museum, Cape Town, Cape of Good Hope, September 2, 1915.

The Aurora Australis of June 17, 1915.

IT is interesting to learn, as a complement to the description of the Aurora Borealis by Prof. Barnard in NATURE of July 15 as accompanying the magnetic storm of June 17, 1915, that a display of aurora was also observed in the southern hemisphere. My correspondent, Mr. W. E. McAdam, writes:—"Upon that day (June 17) there was an exceptionally fine display of the Aurora Australis visible all over New Zealand. Here at Dunedin it commenced at 7.30 p.m., and lasted till midnight. The glow in the southern horizon was quite uncanny in effect, producing the illusion that the sun was about to rise in an impossible quarter of the sky, and at an impossible hour. I have been resident in the Southern Hemisphere off and on for over fifty years, and have never seen anything to equal this last display of the Aurora Australis, a somewhat rare phenomenon in the latitude of Dunedin, 46° south."

A. L. CORTIE.

Stonyhurst College Observatory, Blackburn, Lancs, September 25, 1915.

Distances at which Sounds of Heavy Gun-firing are Heard.

BEING much interested in the question of the distance of propagation of the sound of the firing of big guns, I should be much obliged to any readers of NATURE who could send me some personal observations on the matter, or let me know whether (and when and where) any notices on the subject have been published. Exact references are wanted, as I should try to get the papers containing the information. The gun-firing from the Belgian coast is probably heard in England at times. How far inland? All information will be gratefully received by me.

HENRY DE VARIGNY.

18 rue Lalo, Paris, September 17.

Nodules on the Intermediate Bladderwort.

MR. H. EVANS (NATURE of September 23, p. 88) should refer to Hooker's "Student's Flora," p. 311, Utricularia, "propagated by hybernacula"; and to Babington's "Manual of Botany," p. 339, *Utricularia intermedia* "increasing by buds at the end of the shoots and seldom flowering."

ELEONORA ARMITAGE.

Dadnor, Ross, Herefordshire, September 25.

THEORY AND PRACTICE OF FLYING.[1]

THE present notice refers to three new books on the theory and practice of flying. Although dealing with the same general subject, the ground covered by each is almost entirely different from that of the other two, and each has its own special interest.

"Aeroplanes and Dirigibles of War" deals with the uses of aircraft in the present war and with the methods of repelling aircraft attack by fire from the ground; the work contains very little technical matter, no attempt having been made to enter into details of construction. As showing the part which aircraft is playing in the world-war, the book can be read and appreciated with or without technical knowledge of aeronautics.

The other books under notice are largely technical, referring to aero-engines and to aeroplanes respectively. In the first of these, details of engines suitable for use in aeronautical work are shown with numerous illustrations; there is little theoretical matter, and scarcely any aerodynamics. The book on aeroplanes is, however, almost entirely devoted to aerodynamics, and summarises the important features as affecting the aeroplane so far as they lie within present knowledge. Having said so much generally, the further more particular notes may be of interest:—

(1) The book opens with interesting chapters on the history and development of free ballooning, tracing the military use of balloons back to 1884 and incidentally claiming for the British Government "superiority and initiative." In spite of more recent developments the author says that the use of balloons is still so important that no one of the belligerents will seriously consider their disuse. Passing from balloons to dirigibles, the early struggles of Count Zeppelin with his enormous rigid airships naturally receive much attention. Other types, including the Parseval and Astra-Torres non-rigid airships, come under review, but the author says of the Zeppelins that they have given airship supremacy to Germany. As a somewhat curious offset to this, the author quotes with approval a decision of the American military authorities that "dirigibles are not worth their cost as offensive machines," a decision which may after all prove to have been too sweeping.

After reading these early chapters, the section on aeroplanes is disappointing. In respect to British military machines in particular the author appears to have been singularly misinformed. As an instance of this, it is stated that the BE type of aeroplane has a maximum speed of 40–50 m.p.h., and to anyone acquainted with the technical flight journals such a statement is patently wrong. As a matter of fact, the lowest flight speeds are of the order of those mentioned, whilst the highest were more nearly 70–80 m.p.h. at the beginning of the war.

Coming to anti-aircraft guns and bomb-dropping the book again becomes interesting. One of the illustrations reproduced in Fig. 1 shows a mobile anti-aircraft gun as manufactured by Krupp. Some of these guns are said to throw a shell weighing 40 lb. to a height of 6000–8000 ft., forcing the aviator to similar heights for safety. From such heights the accurate dropping of bombs is a task of some difficulty, and success is often attained only by the pilot running the risk of destruction by shell-fire at much lower altitudes.

FIG. 1.—The latest Krupp anti-aircraft gun, showing novel disposition of wheels. From "Aeroplanes and Dirigibles of War," by F. A. Talbot.

The author concludes with an expression of his opinion that aerial activity will increase with the duration of the war, a prediction which is already being justified by events.

(2) The most interesting and useful part of this book is the description in detail of a number of engines used in flight. The descriptions occupy about three-quarters of the whole and range from

[1] (1) "Aeroplanes and Dirigibles of War." By F. A. Talbot. Pp. xi+283. (London: W. Heinemann, 1915.) Price 3s. 6d. net.
(2) "Aero Engines." By G. A. Burls. Pp. x+196. (London: C. Griffin and Co., Ltd., 1915.) Price 8s. 6d. net.
(3) "The Aeroplane." By A. Fage. Pp. viii+136. (London: C. Griffin and Co., Ltd., 1915.) Price 6s. net.

the 25 h.p. Anzani, with which Blériot first flew the Channel, to some of the more modern engines of 200 h.p. The growth of the art of flying is strikingly illustrated by the fact that whilst 25 h.p. was a useful size of engine in 1909, no present-day aeroplane, other than those for school purposes, has a horse-power less than 80, whilst many considerably exceed this. The celebrated Gnome engine, by means of which Farman and Paulhan achieved their early successes, is described very fully. The power was then a nominal 50 h.p., but really only 42 h.p., but Fig. 2 shows a much larger model weighing only 540 lb., whilst developing 180 h.p. The complication of cylinders which is essential for light engines is most clearly shown in this illustration.

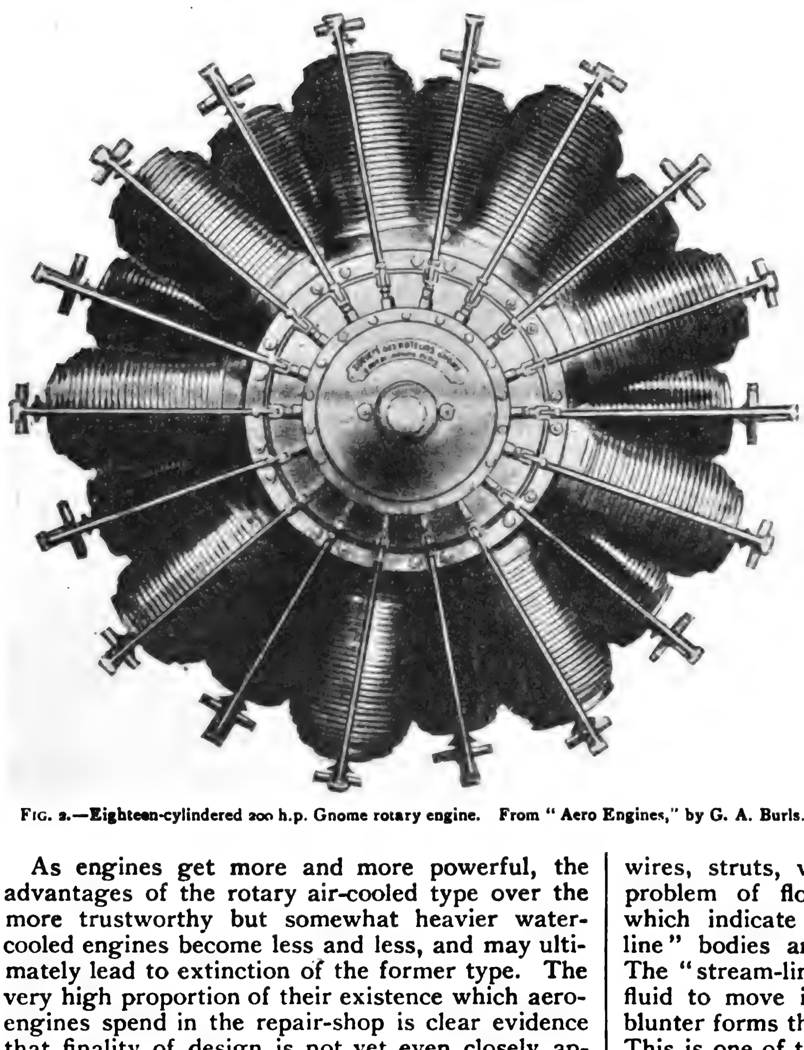


FIG. 2.—Eighteen-cylindered 200 h.p. Gnome rotary engine. From "Aero Engines," by G. A. Burls.

As engines get more and more powerful, the advantages of the rotary air-cooled type over the more trustworthy but somewhat heavier water-cooled engines become less and less, and may ultimately lead to extinction of the former type. The very high proportion of their existence which aero-engines spend in the repair-shop is clear evidence that finality of design is not yet even closely approached, but there is reason to hope that the introduction of large water-cooled engines will considerably reduce the time of repair without the disadvantage of greater weight.

The earlier part of the book contains theoretical matter relating to the working of hot-air engines and follows standard lines in most respects. After contrasting the weights of internal combustion engines, the air-cooled engine of about 3 lb. per b.h.p. with the workshop engine weighing 200 lb. per b.h.p., the author proceeds to a discussion of the working cycle. By some extraordinary calculation he concludes that an engine using the Carnot cycle would weigh 17 tons per b.h.p.; one feels that this is overdone, and that part of the trouble at least is not legitimately laid on the Carnot cycle, but should be borne partly by the designer and partly by the calculator.

Excursions into aerodynamics have already been stated to be few; they are also mostly unfortunate. It is stated that a reduction of gross weight of an aeroplane improves the gliding angle, whereas the two are independent, the effect of reducing the weight being to reduce the flying speed at the same gliding angle. A little later occurs a meaningless statement that "the power, *caeteris paribus,* varies as the cube of the air speed, etc." What the Latin expression covers it is not easy to see; for any given aeroplane the horse-power at first decreases as the speed increases, becomes steady, and then gradually increases. No power of the speed at all can be stated in such general terms. On the same page there occurs a conspicuous error in applying the principles of relative motion to flight in a gale.

These are, however, minor defects which can be put right in later editions, and the information on engines gives the book a right to the bookshelves of all serious students of aviation.

(3) This work is a summary of the dynamics of the aeroplane, and has apparently aimed at the suppression of detail in order to make the important features clear. The early part of the book is based on the results of tests at the various aerodynamical laboratories, on the lift and resistance of wing forms, and the resistances of wires, struts, wheels, etc. In dealing with the problem of flow, photographs are reproduced which indicate the difference between "stream-line" bodies and forms having high resistance. The "stream-line" body is shown as allowing the fluid to move in towards the tail, whilst in the blunter forms the tail region is occupied by eddies. This is one of the more clearly exhibited forms of the effects of viscosity, but in later photographs, showing the velocity of the fluid at any point, the very great difference between the flow round "stream-line" bodies and those of mathematical calculation is almost equally striking.

After discussing the effects of changes of sections of the wings on their efficiency, a few aeroplanes are described, with particulars as to

leading dimensions and weights, and such data is then used to show how the performance of an aeroplane may be calculated. The calculation involves the use of aerodynamical data already described, and also means of estimating the performance of propellers. The usual theory of propeller design is given, and although this now appears to be in need of improvement, the results obtained by its use have been of very great value. In addition to the calculations relating to equilibrium a chapter is included on the question of stability.

The book closes with a short description and discussion of aero-engines, and the whole appears to be very sound. The impression is left, however, that in the attempt to be concise too little assistance has been given to the reader. Like the book on aero-engines, by the same publisher, the production is excellent, the illustrations being particularly clear.

THE VISIBILITY OF DISTANT OBJECTS IN WARFARE.

THE long range of weapons employed in modern warfare has given importance to the study of the appearance of distant objects. A constant contest is taking place between the observer trying to locate the position and numbers of the enemy, and the observer who endeavours by all possible means to conceal these factors.

Generally speaking, an object becomes indistinguishable when its brightness and colour are identical with its surroundings. For this reason such colours as grey and khaki, which blend well with the surroundings, are preferred for modern uniforms. Yet their effectiveness in this respect depends on the nature of the ground over which troops are moving. Khaki is doubtless difficult to distinguish amidst sandy wastes; grey or green might be better against grass or foliage. Of all colours, red is the most conspicuous at a distance. Not only is it the colour which presents the most vivid contrast with the ordinary background, but there appear to be certain physiological factors which accentuate this impression. For example, it is well known that the central region of the eye (which is mainly used for the observation of distant objects) is highly sensitive to the red end of the spectrum and correspondingly insensitive to blue and green. It has also been alleged that, owing to the eye lens not being achromatic, most people find it difficult to focus distant blue and violet light; and that such objects readily merge in the landscape because their outlines are hazy and blurred. Skilful gardeners in designing a flower-bed arrange the blue and lilac flowers in the foreground when possible, and rely on vivid red and orange blooms for a distant effect.

It is known, however, that in a dim light the conditions obtaining in full daylight do not apply. In a feeble illumination the eye becomes more or less colour-blind and is highly insensitive to red, which appears dead black, whereas green and blue objects appear an uncanny grey. A party of men in grey-green uniforms advancing across a grass field in twilight would therefore be extremely difficult to detect.

All this suggests that the problem of selecting an inconspicuous uniform is a complicated one, especially when it is borne in mind that it is also important that bodies of men, besides being inconspicuous to the enemy, should be clearly visible to their own side. It has been suggested that this condition might be secured by differentiation in the colouring of the front and back of the uniform.

It is interesting to observe that on several occasions during the present war scouts have taken special steps to accommodate the colour of their clothing to the surroundings. For example, it is stated that the Germans provided some of their men with white uniforms in order to match the snow in the Polish campaign, and that the Turkish snipers in Gallipoli painted their hands and faces green so as to be indistinguishable amidst foliage.

It is clearly more difficult to secure resemblance to surfaces which are constantly changing, such as the sky and the sea. But there is a second principle which can also be used to secure inconspicuousness in these circumstances, namely, what may be termed the "patchwork" principle. This is based on the experience that the outlines of an object may be rendered difficult to distinguish by breaking up its surface with stripes and patches. This method has been applied to aircraft and hydroplanes, and to forts and temporary defences of various kinds. Besides painting the hulls and funnels of warships a slaty-blue or "battle-grey," experiments have been made with mottled patches of black and irregular serpentine black lines painted on a grey background. Some experiments in this direction recently carried out in the United States Navy are said to have been very successful, and it may be only a question of time before Dreadnoughts are rendered practically invisible at the long range of modern sea-battles.

A combination of patchwork and imitation of surroundings may also be applied with good results in order to conceal aerodromes and similar objects. For example, if the adjacent ground is cleared and the grass is scraped away at intervals, leaving bare patches, and if the aerodrome itself is painted a patchwork of brown and green, identification from above becomes very difficult. Yet another instance is furnished by the recent correspondence in the *Times* regarding the colour of sandbags. It is stated that the Germans insert black sandbags at intervals among those of lighter tint. An officer at the front wrote:—". . . It was the first thing I noticed about the German trenches. Their patchwork device made it impossible to spy their loopholes, whereas ours take a long time to build and then are easily seen."

A device such as this, which would apparently save a considerable number of lives in a long campaign, is well worth attention.

There remains one other possible device for concealing objects which, although difficult to

apply, is probably the most perfect of all when realisable. This is to make use of mirror or semi-mirror surfaces which reflect their surroundings and thus automatically imitate them. Such a device would be applicable in any surroundings.

The chief instance known to the author of the use of this method is afforded by the latest Zeppelins, which are reported to have a coating of bright aluminium powder, which reflects the sky and makes the vessel very difficult to detect at any considerable height. For aircraft flying at a height the problem of concealment is a particularly difficult one, as whatever pigment is adopted the framework is seen silhouetted against the bright sky. It is possible that by making use of reflecting surfaces, in addition to the other devices mentioned, this contrast could be considerably lessened. If to a noiseless engine could be added the quality of practical invisibility, aircraft would become very much more dangerous offensive machines than at present.

Such problems as those mentioned above seem to deserve careful scientific study. Methods of concealment may do much to save the lives of combatants. Moreover, the utility of all vessels employed for scouting purposes, whether aircraft, motors, or submarines, depends to a great extent on their escaping detection. It is therefore surely well worth while to follow up any train of research which offers any promise of approaching invisibility in the future. J. S. D.

PROF. W. H. H. HUDSON.

We greatly regret to record the death, on September 21, of Prof. W. H. H. Hudson, at the age of seventy-six years. Born in London, he graduated as Third Wrangler in 1861. He was then fellow and lecturer of St. John's College until 1882, when he was appointed professor of mathematics at King's College, London. There, and also as professor of mathematics at Queen's College, Harley Street, he worked until his retirement about twelve years ago.

It is as a lecturer, and as a constructive reformer of the teaching of elementary mathematics that Prof. Hudson's vigorous influence will long be felt. Of his numerous pupils many became teachers, and the improvements in modern methods of teaching must be largely due to his inspiration. He edited Barnard Smith's "Arithmetic," published notes on dynamics, gave various addresses on the teaching of elementary mathematics, contributed to the mathematics of meteorology with a theory of anemoids, and did much to promote order and economy in the study of mathematics by adding to its vocabulary terms now generally found useful. He was an active member of the conference which reported to the London County Council on the teaching of arithmetic; of the councils of the London Mathematical Society and of the Mathematical Association; and of the governing body of Newnham College, in the welfare of which (as of the education of women generally) he was warmly interested.

Prof. Hudson's principles received remarkable vindication in the record of his family. By the tragic death on Snowdon, in 1904, of his only son, Cambridge lost one of its most brilliant Senior Wranglers, and perhaps the most widely accomplished. The researches of Ronald Hudson in Kummer's "Quartic Surface," published posthumously, placed him in the front rank of geometers. The three surviving daughters of Prof. Hudson have all distinguished themselves as mathematicians.

Few men intimate with the austerities of the most difficult of subjects can have made a wider circle of personal friends than did Prof. Hudson. He had the gift of humour and sympathy which endeared him to all those he taught. He enjoyed travel and recreation to the end of his days, and within the boundaries of mathematical study he knew how to find both.

NOTES.

The Rev. Dr. E. W. Barnes, fellow and tutor of Trinity College, Cambridge, has been appointed to the mastership of the Temple. Dr. Barnes is in his forty-first year, and had a brilliant career at Cambridge. He went up to the University as a scholar of Trinity College, and in 1896 was bracketed second Wrangler. A year later he took a first class in the first division of the Mathematical Tripos, part ii., and was first Smith's prizeman in 1898, besides being president of the Union. He was elected a fellow of his college in the same year, and was an instructor at the Royal Military Academy, Woolwich, in 1898–99. He is the author of various memoirs and papers on Gamma functions, integral functions, linear difference equations, and related mathematical subjects.

The Victoria Cross is given for conspicuous courage in the face of the enemy: and, if we want a good example of such courage, we have it in the English nurse, at the American Hospital at Neuilly, who inoculated herself with a pure culture of the bacilli of gas-gangrene, that she might help the discovery of the best treatment of that disease. We rejoice that she now is out of danger of death. The annals of medicine record many similar instances of self-devotion, and doubtless there are others which have gone unrecorded. They have not always been of use to mankind: John Hunter, for example, inoculated himself with the virus of one of the venereal diseases, but drew a wrong conclusion from the results of the experiment. The amazing self-experiments with yellow fever, in Camp Lazear, were happily not in vain. The protective treatments against cholera, plague, and typhoid fever were, of course, well tested by their discoverers on themselves before they were put to national uses. A good essay is waiting to be written on the whole subject of self-experimentation. Lord Moulton, in his evidence before the Royal Commission on Vivisection, discusses the ethics of it, and he does that very well. But formal ethics scarcely touch the case; the self-experimenter, in the presence of the enemy, the germs, the havoc they work on men, women, and children, "sees red," and behaves

accordingly. We salute with reverence this big-hearted Englishwoman, but we beg of her that she will not do it again.

WE regret to learn of the death, on September 8, at eighty-one years of age, of Dr. Ugo Schiff, professor of chemistry in the R. Istituto di Studi Superiori, Florence.

DR. C. H. WING, professor of chemistry at Cornell University from 1870 to 1874, and at the Massachusetts Institute of Technology from 1874 to 1884, died recently at the age of seventy-nine.

THE death is announced, in his fiftieth year, of Dr. K. E. Guthe, professor of physics at the State University of Iowa from 1905 to 1909, and at the University of Michigan since the latter date. A native of Hanover and educated in Germany, he went to the United States in 1892. He was a member of the jury of awards (electricity) at the St. Louis Exposition in 1904, and had made several contributions to the literature of physics.

NATURALISTS, and especially ornithologists, throughout the British Islands are the poorer for the sudden death on September 15 of Mr. R. M. Barrington, of Fassaroe, Bray, Co. Wicklow. Though in his sixty-seventh year, he was still full of activity and of enthusiasm for his favourite studies. An admirable example of the "all-round" naturalist, Mr. Barrington will be especially remembered for his work on the migration of birds. From 1880 he collected specimens forwarded to him by lightkeepers around the Irish coasts, and the results of these observations were published in a substantial volume in the year 1900. Many birds were thus recognised for the first time as Irish species—such as the yellow-browed warbler, the aquatic warbler, the barred warbler, Pallas's grasshopper warbler, the short-toed lark, the shore-lark, the mealy and Greenland redpolls. The specimens accumulated were either passed on to the National Museum in Dublin, or preserved in Mr. Barrington's beautifully kept private museum at Fassaroe, in which he took great pride and pleasure, and which he was always ready to show to friends, expounding the while from the wide experience with which his memory was stored. He was a keen botanist, having in his younger days paid especial attention to the Alpine plants of Ireland. He threw himself heartily into many enterprises for extending biological knowledge and interest, having been one of the founders of the Dublin Naturalists' Field Club, and a valued member of council of the Royal Irish Academy, the Dublin Society, and the Zoological Society of Ireland. To his wide knowledge of natural history there were added a personal charm and a kindly humour which will make the memory of his friendship a high privilege.

IT has been found that at the present time there are three main causes which delay the production and repair of aircraft and their parts, namely, lack of co-ordination between those engaged in aeroplane construction, difficulties of finance, and shortage and wastage of labour. To remedy these disadvantages, it is proposed to establish a central body under the title "Aeronautical Production Committee" or some similar name, the functions of which will include the promotion of co-operation and co-ordination in the aeronautical industry, the provision of technical assistance otherwise unobtainable for financial institutions, and the development of arrangements for the better utilisation of the existing labour and the training of as many men for aeronautical work as the situation demands. It is estimated that an expenditure of about 100*l.* per week would enable the committee to supply the Army and Navy with seven more aeroplanes every week, and it is suggested that the sum might be raised partly by a Government subsidy, partly by a small fee charged to the makers for the benefits they would derive from the central bureau, and partly by voluntary subscriptions. The scheme has received the support of many eminent authorities, and further particulars can be obtained from the temporary secretary, Mr. L. Blin Desbleds, 39 Victoria Street, Westminster, S.W.

JUST before five o'clock on Thursday morning last, September 23, a fire was discovered in the Technical School buildings, Market Street, Newton Abbot, and although the firemen succeeded in confining the outbreak to one room, much damage was done to the school museum, which included the life-long collection of the late Mr. W. Vicary, of The Priory, Exeter, bequeathed some years ago to his nephew, Mr. W. Vicary, chairman of the governors of the Technical School. The collection was considered to be one of the finest out of London, and many specimens were believed to be unique. It included thousands of specimens of minerals, some being very fine and rare. There were also some fine old flints from Dartmoor, stone implements, and a valuable collection of corals. Specimens from all parts of the world were included in the collection, and many cannot be replaced. There was also an extensive collection of butterflies of numerous varieties, and some magnificent examples of sampler work, some dating from the sixteenth century. The massive cases, valued at about 300*l.*, were completely destroyed, and it is probable that the bulk of the collection is rendered useless by the great heat. Other things lost are the records of the school from 1868, the year of its inception, and a collection of photographs, most of which cannot be replaced, of people who have been connected with the school.

A HOME Grown War Food Exhibition, organised by the *Daily Mail*, was held at the Horticultural Hall, Westminster, last week. When it is considered that the growth, development, and power to function of all the tissues of the body are derived directly from the foodstuffs ingested, there need be no apology for investing these substances with an importance of the first order. To say that the exhibition was a success falls far short of the whole truth It has demonstrated that British people in their thousands (there were more than 20,000 competitors) can produce wheat, vegetables, eggs, butter, cheese, honey, and jams in quality as fine as any other nation in the world. Whether most of these foodstuffs can be produced as cheaply in this country as in France and

Germany remains to be seen. In agriculture, as in art and most departments of human activity, the French do things with singular brilliance and address. Now that we are drawn so closely to France, our agriculturists have excellent opportunities for studying her methods in the various ramifications of their calling. There is evidence to show that the freshness of food plays an important *rôle* in nutrition and problems of health. Since certain vegetables and fruits cannot be imported (even from the Continent) in a thoroughly fresh state, it follows that they should be raised at home. Apart from cost of carriage, there is no reason why we should not produce all our kitchen-garden material, many fruits, eggs, and butter and cheese as cheaply as any nation on the Continent. It requires no argument to-day to establish the contention that the health and physical conditions of the workers in this field are immeasurably better than in any sphere of activity afforded by the city. The only suggestion we have to make relating to the exhibition is that if a label bearing the name of the particular variety of foodstuff were attached to each exhibit, it would afford some valuable information to competitors and visitors. We should now like to see a further exhibition in the form of practical demonstrations of how the various foodstuffs should be cooked.

THE destruction of housefly maggots in manure and other food-stuffs is nowadays a pressing question with sanitary officers. Some recent American experiments are described in Bulletin 245 of the U.S. Department of Agriculture, written by Messrs. F. C. Cook, R. H. Hutchison, and F. M. Scales. Borax and powdered hellebore are found to be the most effectual "larvicides" of all the substances tested.

THE Trustees of the British Museum (Natural History) have published a valuable little pamphlet (Economic Series, No. 2), by Mr. Bruce F. Cummings, on the louse and its relation to disease. The structural distinctions drawn between the head louse and the clothes louse will be of interest to systematic entomologists, while the practical importance of the parasites as carriers of typhus and other diseases is duly emphasised.

THE Food Plants of the Gipsy Moth (*Porthetria dispar*) in America form the subject of Bulletin 250 of the U.S. Department of Agriculture by Mr. F. H. Mosher. From the careful experiments that he describes it has been established that the caterpillars eat, and thrive on, forty or fifty different kinds of trees. It is evident that such discursive feeding-habits make attempts to destroy the insects more difficult.

THE asparagus-beetle (*Crioceris asparagi*) is a well-known pest in Europe and North America. The life-history of its chalcid parasite, *Tetrastichus asparagi*, as lately described by Mr. F. A. Johnston (Journ. Agric. Research, Washington, vol. iv., No. 4), is of remarkable interest. The tiny fly lays usually from five to seven eggs in an egg of the beetle. The beetle's egg nevertheless hatches; the larva becomes fully grown, and, entering the soil, forms a pupal chamber. It never pupates, however, as the chalcid grubs have been feeding and growing within it; they crawl out of the dried cuticle and pupate in the earthen chamber which the host-larva has made.

AN interesting account of the colony of grey seals (*Halichoerus grypus*) of Skerryvore is given in the *Scottish Naturalist* for September by Mr. R. Wilson, of the Skerryvore Lighthouse. This colony, numbering from sixty to eighty, takes up its residence on the outlying rocks every summer, the majority leaving before the winter sets in. Among other things, he refers to their pugnacity towards one another, at any rate so far as the bulls are concerned, and of their curiosity.

THE *Zoologist* for August contains several interesting ornithological papers. Dr. J. M. Dewar discusses the relation of oyster-catchers to their environment from observations made along the Firth of Forth; he finds that the access of the birds to their feeding-grounds in winter is largely dependent on the movements and activities of the human population of the district. The Rev. J. M. McWilliam describes the habits of the tree sparrow in Co. Donegal, mentioning that a couple of males were observed feeding young in one nest, while a lonely female "was sitting on another nest not very far away." Mr. E. Selous continues his "Diary of Ornithological Observations" made in Iceland.

FURTHER notes on the colour sense in bees, from the pen of Mr. C. B. Moffat, appear in the *Irish Naturalist* for September. Mr. Moffat is of opinion that colour is a negligible factor as a means of guiding bees in their search for nectar. They depend rather, he believes, on some subtle sense, perhaps of scent, which enables them to keep to plants of one particular species during each separate journey to the hive. On the return from the hive plants of another species may be visited. Plants of the same species bearing respectively, say, pink and white flowers are visited in succession and at random, but neighbouring plants of different species, bearing flowers of the same hues, are avoided.

EXTENSIVE areas of floating oil off the east coast of Scotland have caused the death of enormous numbers of guillemots, razorbills, and puffins, and a considerable number of eider-ducks. Details as to this extraordinary occurrence appear in the *Scottish Naturalist* for September. Lady Erskine reports that on June 22 at Kingsbarns the rocks were covered with a thick, brown oil, some seven inches deep in the crevices. Dead birds were lying all along high-water mark, and large numbers in a dazed condition, and, with their feathers matted together with oil, were sitting about. Some eiders were also found in a similar pitiable plight. The keeper of the Isle of May lighthouse, on June 16, found birds similarly coated on the rocks, and unable either to fly or swim. Large sheets of oil drifted to the island, and all the creeks on the east side were full of it. The Misses Rintoul and Baxter on June 29 found hundreds of dead guillemots, razorbills, and puffins, and some eiders, on the shore at Cambo. They also report further victims from Largo

Bay and round the shores of Fife. In all these cases the birds were unable either to fly or dive, and hence died of starvation. So far no explanation of this floating oil has come to hand. Probably it escaped from a torpedoed ship bearing a cargo of lubricating oil.

THE current number of the *Quarterly Journal of Microscopical Science* (vol. lxi., part ii.), though considerably diminished in size, contains some very interesting matter. Mr. E. S. Goodrich's article on the chorda tympani and middle ear in reptiles, birds, and mammals should be welcomed by all students of comparative anatomy. In these days of embryological hair-splitting it is refreshing to find that he is able to give a whole-hearted adherence to the much debated theory that the stapes and columella are derived from the hyoid arch, while the incus and malleus correspond to the quadrate and articular respectively. The attention of teachers may be directed to some extremely useful diagrams contained in this memoir, especially text-figure 2, showing the relations of the auditory ossicles and associated structures in reptiles and mammals. Another article in the same number, dealing with the placenta of a lemur, is from the pen of the brilliant Oxford embryologist, Dr. J. W. Jenkinson, whose recent death while fighting in the service of his country is so deeply to be deplored.

W. H. BROWN and D. M. Mathews, in the *Philippine Journal of Science* (vol. ix., Nos. 5 and 6, pp. 413–561), give the results of an elaborate study of the Dipterocarp forests of the Philippine Islands. At low elevations throughout the Indo-Malayan region, the important forests, capable of yielding an extensive supply of timber, are those in which the dominant trees belong to the family Dipterocarpaceæ. Forests of this class occur in the Philippines from sea-level to 2500 ft. elevation, and cover an area of 30,000 square miles. Different types occur, the ecological and silvicultural features of which are well described by the two authors, who give numerous tables of the rates of growth of the main species, and discuss at great length the most suitable methods of utilising the timber, which will ensure successful natural regeneration on the felled areas. Artificial replanting appears to be impracticable. The prevalent opinion that most of the woods of the tropics are very hard and heavy, and consequently only fit for ornamental uses, is not supported by these investigations. On the contrary, it is believed that enormous supplies of soft and light timbers, just as suitable for building purposes as the pine and spruce of northerly regions, will eventually be procured from the tropical Dipterocarp forests, which often consist of dense stands of a few species, that may be logged at a small cost. An export trade in such timber from the Philippine ports has lately been rendered possible by the introduction of cheap American machinery.

THE last issue (1913–14) of the *Bulletin Hydrographique*, published in Copenhagen by the Conseil permanent international pour l'Exploration de la Mer, contains physical observations taken, chiefly in the North Sea, from July, 1913, to June, 1914. The volume includes an admirable series of finely executed maps illustrating salinities and currents, the former in the North Atlantic as well as the North Sea. The current observations are discussed at some length, but the available data are still insufficient to allow laws to be formulated with regard to mean current conditions. Unfortunately, the war has interrupted this international effort, but it is to be hoped it will be continued later. At most stations measurements have been made at 10 metres' depth and near to the bottom, and at fortnightly intervals for three years. The tidal current seems to be least in the Skagerak and the northern central part of the North Sea, greater in the vicinity of the coasts and in the eastern and western parts, and greatest in the southern portion between the Channel and 53° N.

IN *Naturen* for July and August, 1915, C. F. Kolderup discusses and illustrates the Devonian flora of Vestland, between the Nordfjord and the Sognefjord of Norway, on the basis of his researches from 1899 onwards, aided by material in the University collections at Kristiania. The plant-remains confirm the older suggestions as to the age of the sandstones and conglomerates, and the presence of the Orcadian *Thursophyton milleri*, which is probably a Lycopodiale, suggests a Middle Devonian horizon.

DISCUSSIONS of the anemographic observations recorded at Deesa from January, 1879, to December, 1904, and at Karachi from January, 1873, to December, 1894, by W. A. Harwood, are given in vol. xix. of the Memoirs of the Indian Meteorological Department; the discussions are numbered respectively VII. and VIII. There is an introduction by Dr. G. T. Walker, and descriptions are given of the two stations. The year at Deesa is divided into three seasons: the cool season, October to February; the hot season, March to May; and the rainy or south-west monsoon season, from June to September. As each season has its characteristic winds, the data are discussed under the three divisions. At Karachi the year is divided into similar seasons, which embody similar months to the discussion at Deesa. The greatest air movement at Deesa corresponds to the direction of maximum frequency throughout the year. It is north-east in the cool season, and shifts round through west during the hot season to south-west in the rains. At Karachi the predominant movement and the highest velocities are recorded from south-westerly directions at all seasons. The hourly velocities and co-ordinates of wind movement are given for each month for each of the two stations, and there are monthly wind-roses and other diagrams.

WE are glad to see that the war has not interfered with the publication of that very useful periodical, the Journal of the Royal Microscopical Society. In addition to the usual summary of current researches, the August number (part iv., 1915) contains an interesting article by Mr. Charles Singer on the "Dawn of Microscopical Discovery," with reproductions of some microscopical drawings of early date and portraits of some of the pioneers of microscopical science. According to the author, the pioneer period, with which his article exclusively deals, terminated about the year 1660, and was succeeded by the classical period, in

which flourished the great microscopists Hooke, Grew, Malpighi, Leeuwenhoek, and Swammerdam. Amongst the pioneers themselves are included such well-known names as Fabio Colonna, Galileo Galilei, Federigo Cesi, and Athanasius Kircher.

THE June number of *Terrestrial Magnetism and Atmospheric Electricity* contains the results of the measurements of the deviation of the magnetic compass from true north made on the magnetic survey ship *Carnegie* during her voyage from Brooklyn to Honolulu *viâ* the Panama Canal in the spring of this year. The corrections to the British Admiralty Chart are very small over the course from Brooklyn to the West Indies, but in the neighbourhood of the passage between Dominica and Porto Rico the chart gives the westerly deviation more than a degree too small. Across the Caribbean Sea the chart is within a few tenths of a degree of the Carnegie results, but in the first 30° of the course across the Pacific our charts give the easterly deviation about a degree too small. At greater distances from the American coast the error falls to one or two-tenths of a degree, and is sometimes an excess, sometimes a deficit, in the easterly deviation.

IN the Journal of the Franklin Institute for September, Mr. W. S. Bartholomew, president of the Locomotive Stoker Company of Schenectady, says that under average conditions any locomotive, freight or passenger, which has a maximum tractive effort of 50,000 pounds, or burns 4,000 pounds or more of coal per hour for an extended period, one hour or more, should be fired by mechanical stoker. It appears that about 1,200 locomotives in the United States have had mechanical stokers fitted, and about one thousand of these were in use in April last. Some six hundred are Street stokers of the over-feed type, and 365 are Crawford stokers of the under-feed type. It is claimed that the mechanical stoking of locomotives raises the efficiency of the locomotive by increasing the earning power, and also raises the efficiency of labour by making it possible for one crew to handle more traffic per train unit, or the same train unit with greater ease. It also lessens the arduous physical labour of the fireman, and lifts the grade of his employment.

THE *Engineering Magazine* for September contains the first of a useful series of articles by Prof. J. C. Smallwood on recording power plant operations. Descriptions are given of coal meters, feed-water meters, and steam-flow meters; these are thoroughly well illustrated from photographs and working drawings, and contain much information of value to engineers. Coal-weighing apparatus may be classed as registering meters, automatic coal scales, and hand-adjusted weighers. It does not appear that there is any autographic coal meter on the market, although it would appear that such a one would be of distinct use, especially in connection with mechanical stokers. Among water-flow meters, the V-notch weir meter has recently found much favour, as it may be combined with a feed-water heater. Other water-meters described are operated under the Pitot principle, the Venturi principle, and the principle of volume measurement in tanks. Steam-flow meters applied to individual boilers show the instantaneous steaming rate. A meter attached to each boiler of a battery of boilers will show if any boiler is "loafing." The Pitot and Venturi principles are also made use of in steam-flow meters. In the St. John meter the flow takes place through an orifice in which is a conical plug. A difference of pressure of about 2 lb. is maintained. When the flow increases the plug rises, and thus gives an increased area of orifice. A lever system connects the plug to the recording pen.

THE forthcoming books of the *Oxford University Press* include:—The Cures of the Diseased in Remote Regions. Reproduced in facsimile from the original issue of London, 1558, with introduction and notes by C. Singer; Origin and Meaning of some fundamental Earth Structures, by C. P. Berkey; Contributions to the Ethnology of the Salish Tribes, by J. A. Teit; Architectural Acoustics, by W. C. Sabine; Scientific Management, by C. B. Thompson; The Evolution of Modern Medicine, by Sir W. Osler; Geography of Eastern Asia, by D. Paton. *Messrs. Crosby Lockwood and Son* announce, in their "Manuals of Chemical Technology":—Chlorine and Chlorine Products, by Dr. G. Martin, with a chapter on Recent Oxidising Agents, by G. W. Clough; Sulphuric Acid and Sulphur Products, by Dr. G. Martin and J. L. Foucar; The Salt and Alkali Industry, by Dr. G. Martin and S. Smith, with chapters on the Stassfurt Industry and Potassium Salts, by F. Milsom. Further books of science to be issued by the *Cambridge University Press* are:—A Student's Book on Soils and Manures, by Dr. E. J. Russell, illustrated (Cambridge Farm Institute Series); Archæological Excavation, by J. P. Droop (Cambridge Archæological and Ethnological Series); Ticks: a Monograph of the Ixodoidea, part iii., the Genus Hæmaphysalis, Bibliography of the Ixodoidea, ii.; North America during the Eighteenth Century: a Geographical History, by T. Crockett and B. C. Wallis, illustrated; Cambridge Elementary Arithmetics, by J. H. Webster, Teacher's Books V., VI., and VII.; A First Course of Geometry, by Dr. C. Davison; Experimental Physics: a Text-book of Mechanics, Heat, Sound, and Light, by Dr. H. A. Wilson, illustrated (Cambridge Physical Series); An Introduction to Applied Mechanics, by E. S. Andrews, illustrated (The Cambridge Technical Series); Ships, Shipping, and Fishing: with some Account of our Seaports and their Industries, by G. F. Bosworth, illustrated (Cambridge Industrial and Commercial Series).

A CATALOGUE of books and papers on economic zoology and other subjects just issued by Messrs. J. Wheldon and Co., 38 Great Queen Street, W.C., contains the titles of many works of interest to naturalists. We notice that complete sets of reports and other publications difficult to obtain are offered at reasonable prices, and also rare works on fish and fisheries, marine biology, and economic entomology. Librarians and private workers who consult the catalogue will find in it a number of volumes well worth purchasing.

OUR ASTRONOMICAL COLUMN.

A New Comet.—A Copenhagen telegram reports the discovery of another comet by Mr. J. E. Mellish. In addition to the signatures of Profs. Pickering and Strömgren, the message bears the name of Aitken, and the position of the object appears to have been measured at Lick. Thus there are sufficient grounds for presuming an authentic comet has been detected, although the communcation contains no information regarding the movement (or magnitude) of the object. Its position on September 19 16h. 19m. 2s., Lick time, was R.A. 10h. 37m. 54s., dec. 26° 13′ 17″, *i.e.* between 40 and 41 Leo Minoris.

With reference to the note in this column last week, readers who have not the opportunity of consulting Dreyer's Catalogue may be interested to learn that N.G.C. 2261 is therein stated to show a cometic nucleus.

The Variation of Latitude.—Two papers in recent numbers of the *Astronomische Nachrichten* bear on this subject. In No. 4811 Dr. E. Przybyllok publishes results of an investigation into the effect on latitude determinations of that part of the atmospheric refraction due to the air inside the observatory differing in temperature from the external. It is found that measures of the altitude of the pole show a daily fluctuation in magnitude varying directly with the altitude of the sun. Among the numerous citations —there seems to be no reference to the work of Mr. S. Shinjo—one significant item concerns a systematic difference amounting to 0·11″ found between visual and photographic determinations caused by the heating effect of a small dark-room lamp fixed to the south of the photographic zenith sector.

In No. 4812 von B. Wanach discusses the Kimura term "z." Dr. de Sitter's view is adopted that the greater part of this term is due to the method of reduction. Refraction anomalies are considered to be a sufficient cause for the remaining part. The "z" term having been hypothesised out of existence, the attempt is made to modify the group corrections as obtained by the "Kettenmethode," so that in the mean "z" vanishes for all stations and years. To this end a modified "z" is taken as a negative declination correction, and new values are derived for the group corrections for the six northern international stations. The differences between successive groups show an annual oscillation having a maximum in spring and a minimum in autumn, whilst the amplitudes for the three Continental stations markedly exceed those at the "maritime" situations, thus indicating the probability that variations of zenith refraction of meteorological origin are operative.

Stellar Proper Motions determined Stereoscopically.—Quite recently M. Comas Sola, of the Barcelona Observatory, recorded some qualitative observations of stellar cross-motions obtained by stereoscopic comparison of stellar photograms (this col., August 26). According to the *Astronomische Nachrichten* (No. 4811) it now appears that Prof. Max Wolf has employed the stereoscope most successfully in quantitative determinations. Results are given of measures of the proper motions of eight stars in the neighbourhood of σ Leonis made on plates secured with the 16-in. Bruce telescope at an interval of 12·108 years, one of the plates having been taken in 1903, the other in the early part of the present year. The stars measured range from 7·0–12·5m. magnitude, and the yearly motions vary from 0·31″ to 1·18″. Some of the stars have been measured previously, *e.g.* the pair 83 Leonis by Kobold among others, who found the annual motion of 0·77″, whilst the new method gives 0·74″ for the same quantity.

Rotation Period of Neptune.—Mr. Maxwell Hall has published (Monthly Notices R.A.S., vol. lxxv., No. 8) the results of photometric observations of this planet made during its recent opposition; thirty-five measures of magnitude were obtained during the period February 26 and May 10 of the present year. The magnitude ranged from 6·87 to 7·76, and the period which best fitted the measures was 7h. 50m. 68s. Similar observations made during November, 1883, gave a period of 7h. 55m. Greater continuity in the series of observations is necessary, and the co-operation of observers well distributed in longitude is therefore invited.

The Internal Constitution of the Earth.—Mr. Harold Jeffreys, who has recently published several important theoretical investigations on the physics of the earth and moon (Mem. R.A.S., vol. lx., part vi., and Proc. R.A.S., vol. lxxv., No. 8, pp. 648–658), contributes a very useful article to the current number of the *Observatory* on the mechanical properties of the earth. A good idea is given of the manner in which a number of apparently widely differing lines of investigation have in reality converged in adding to our information—albeit at times in a somewhat conflicting fashion—regarding the state of the earth's interior.

Photometric Observations of δ Cephei.—During the period June 10–September 26, 1914, Dr. Giuilo Bemporad and Dr. V. Fontana collaborated in making a fairly numerous series of photometric measures of the light of this star. Dr. Bemporad's results appear in the *Mem. Spett. Ital.*, June, 1915. The mean light curve shows a secondary maximum, and at a later phase an inflection. A further analysis of the data was made with special reference to the secondary oscillations.

The Evolution of the Stars and the Formation of the Earth.—The second course of lectures on the William Ellery Hale foundation was given at the meeting of the National Academy of Science at Chicago last December by Dr. W. W. Campbell under the above title. These lectures are now being published in *The Popular Science Monthly*, beginning in the September number.

THE ETNEAN EARTHQUAKES OF MAY, 1914.

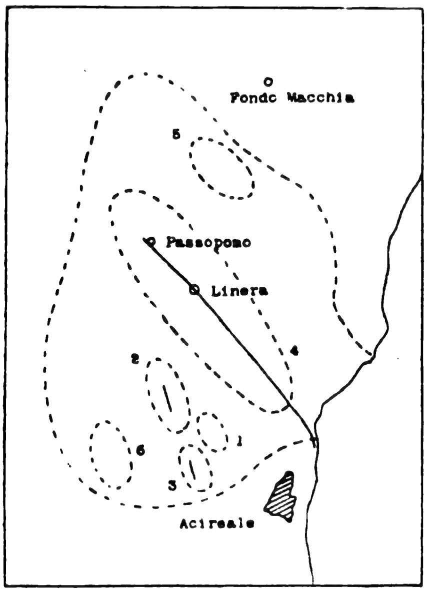
The term *volcanic earthquakes* has for long been applied to all earthquakes originating within the bounds of active or dormant volcanoes. Such earthquakes are usually distinguished from ordinary tectonic earthquakes by their small disturbed areas, the great intensity of the shocks near the centres of those areas, the brevity and abruptness of the shocks, and the comparative absence of fore-shocks and aftershocks. While the countless tremors which precede and accompany volcanic explosions are no doubt the effects of such explosions, it has been assumed, perhaps rather hastily, that all volcanic earthquakes are as intimately connected with the volcanic operations. Several recent investigations (see Nature, vol. xcii., pp. 716–7; vol. xcv., p. 215) have, however, shown that many volcanic earthquakes are of a tectonic or semi-tectonic character, and that both earthquakes and eruptions are in all probability effects of the same cause or causes.

The more important Etnean earthquakes evidently belong to this category. They originate beneath the volcano—in recent cases, below its eastern flank—and they are closely associated in point of time with explosions or periods of increased activity of the volcano. Moreover, their seismic foci are at a slight depth. On

the other hand, the meizoseismal areas are much elongated and their longer axes are directed roughly towards the central crater and at right angles to this direction, implying that they are probably due to slipping along radial and peripheral fractures (see NATURE, vol. xciii., pp. 272–3).

The earthquakes of May, 1914, on the eastern flank of Etna, supply useful evidence on this subject. They have been studied with great care by Prof. Gaetana Platania,[1] who, with ample materials at his command, confirms the conclusion arrived at in the last-mentioned paper. Several of the shocks, besides the principal earthquake of May 8, were of destructive intensity, and the outer broken line on the accompanying map includes all the places in which houses were damaged by the different shocks.

Slight earthquakes were felt within this area on April 28 and 30, and May 1 and 2. The series proper began on May 5. On May 7 at 5.35 p.m. (G.M.T.) there was a strong double shock, the two parts being separated by an interval of three to four seconds. In the epicentral zones, indicated by the curves Nos. 1 and 2, walls were cracked and some houses damaged.



This may, as Prof. Platania suggests, have been a twin-earthquake, but the evidence is insufficient to decide the point. Soon afterwards, at 9 p.m., another strong shock caused slight damage within the area represented by the curve No. 3.

On the morning of May 8, only light vapours were being emitted from the central crater of Etna and from the vent on the north-east flank opened in May, 1911. At about 5.30 p.m., however, extraordinary activity was manifested in both, and this continued for several days with a first maximum on the evening of May 10, and activity above the average for the rest of the month.

Shortly afterwards, at 6h. 1m. 30s. p.m., occurred the principal shock of the series, by which the towns of Passopomo, Linera, Cosentini, Carico, and Mortara were destroyed. The meizoseismal area is an elongated ellipse (No. 4), about 6 km. long and 2 km. wide. There was also a detached area of somewhat less destruction (No. 5). Within the meizoseismal area not only were the houses ruined, but the ground itself was crushed. A slightly sinuous fracture traverses the axis of this zone, as shown by the continuous line in the map, and in its neighbourhood the ruin was complete. Throughout its course there is almost everywhere a change of level, in some places of a few centimetres only, in others of as much as 40 centimetres or more, the ground on the north-east side being depressed relatively to that on the south-west side. There are also traces of a slight horizontal displacement.

Between May 8 and June 4 thirty after-shocks were recorded, only one (that of May 28) being of any importance. The meizoseismal area of this shock is indicated by the curve No. 6. Prof. Platania notes that there were other migrations of the epicentres besides those noted above. He concludes that, during this seismic period, the whole eastern flank of Etna was disturbed, probably by subterranean movements of the magma, which were responsible both for the increased activity of the volcano and for the slips along radial fractures which resulted in the earthquakes.

C. DAVISON.

1 Sul periodo sismico del maggio 1914 nella regione orientale dell' Etna, *Publ. dell' Ist. di Geogr. Fisica e Vulcanologia della R. Università di Catania*, No. 5, 1914. Pp. 1–48.

METEOROLOGY WITHOUT INSTRUMENTS.[1]

THOSE who have been compelled to wade through the long-continued record of meteorological observations know and dread the serried columns of figures that tell of the scrupulous care with which the conscientious observer has read his barometer and thermometer. As a rule, it is impossible to inspire the mechanical and lifeless record of the weather of the past year, or of the past decade, with any lasting interest, but Mr. Backhouse, departing from stereotyped methods, has given us a book on climatology that does not weary by its monotony or tire by its endless repetitions.

Much of the success and charm of this volume depends upon the fact that it is a human document, recording what has been seen and experienced, not what is automatically registered by ingeniously devised instrumental methods. It is a revelation of character as well as an inquiry into the variation of climatic factors. This record goes back to the time when the author was a schoolboy at York, and demonstrates the value of habits of accurate and intelligent observation, diligently preserved through life. With perseverance and practice has come an acuteness of perception that has made Mr. Backhouse one of the most successful observers of those minute differences in the appearance of the sky or of the atmosphere that escape untrained observers, who prefer to consult the barometer rather than natural phenomena. And with the increased capacity for observation has come apparently the greater opportunity for exercising it. To most people, the observation of such phenomena as lunar rainbows or parhelia is a rare event, and without such a trustworthy record as we have here, many would be inclined to doubt their frequency. Take again such instances as the successive alternation in the wind direction, known as "land and sea breezes." Although the cause is operative all over the world, we have come to regard these winds as confined mainly to a few tropical localities, and believe that it would be vain to attempt their observation, except in these favoured spots. But Mr. Backhouse shows how the attentive observer can study the behaviour of these alternating breezes on our own coast, and even mark the varying direction, as the azimuth of the sun, at rising and setting, changes at different

1 Publications of West Hendon House Observatory, Sunderland. No. iv. Meteorological Observations, chiefly at Sunderland. By T. W. Backhouse. Pp. v+188. (Sunderland: Hills and Co., 1915.)

seasons of the year. More important than the record of the facts themselves is the consciousness of how much we miss from failing to cultivate methodical habits of observation.

The manner in which the information is presented and made available adds to the interest attaching to the method of collection. The author sums up his accumulated records, extending over forty years or more, in diagrams, that appeal to the eye. Wind-roses are a familiar device for exhibiting frequent and lawless changes. Similar contrivances are largely used, and demonstrate clearly that the north and east winds grow in frequency as the year advances towards the summer, to be followed later by the increase in the west winds, through the autumn and early winter. The land and sea breezes are similarly treated, and the diagrams are equally instructive. The dependence of rain on wind is also illustrated diagrammatically, and the resulting figures are deserving of close study. The chapter on the prevalence of fog and mist, as determined by the visibility of prominent objects, is of special interest, for it is a kind of observation that cannot be assisted by instruments, but depends solely for its accuracy on the skill and vigilance of the observer, qualities in which Mr. Backhouse excels.

THE BRITISH ASSOCIATION.

SECTION G.

ENGINEERING.

OPENING ADDRESS[1] BY H. S. HELE-SHAW, D.Sc., LL.D., F.R.S., M.INST.C.E., PRESIDENT OF THE SECTION.

THE preparation and delivery of a presidential address is usually a pleasant and not difficult task, although it seems to be the custom mildly to intimate to the contrary. In ordinary times the president chooses a subject on which he has done some work, and with which he is therefore familiar, and with which, moreover, his name is more or less associated. If this had been an ordinary time, I should have liked to deal with the fascinating subject of mechanical locomotion, and to review what has taken place, let us say, since the meeting of the British Association held in Manchester rather more than half a century ago. But the time is not an ordinary one, for the war which a year ago cast its shadow over the meeting of the British Association in Australia has, as the months have passed by, gradually unfolded the most terrible page in the history of the world.

It is terrible not merely because of the frightful slaughter which has taken place and which will yet take place, owing on one hand to the gigantic armies employed, and on the other to the nature of modern warfare. A predecessor in the chair, one who has left many marks of his genius on the peaceful engineering works of the country, Mr. Hawksley, commented about fifty years ago on "the unhappy necessity of devoting so much of the science and skill of members of the association to the defence of the homes of the people of this great nation."

This is not the place to dwell at any length on the subject of the war; but I cannot help pointing out that the whole attitude of scientific and professional men in this country at the beginning of the war shows how little they realised the real nature of what was before us; but we now know that the only way to escape from destruction ourselves is to employ all the resources of science in our own defence.

It is partly on these grounds that the meeting of the British Association for the Advancement of Science has been held this year, because science is proving such an all-important factor in the present war.

The mere holding of this meeting, however, with a vague sort of idea that science is associated with war, does not seem to most of us to meet the real needs of the case. The decision to hold the meeting was made in March, *i.e.* six months ago. Since that time the nation has awakened to the fact that matters have become very much more serious, and we scarcely needed the solemn warnings of our responsible statesmen to enable us to realise this. We see our foe turning every resource towards the active prosecution of the war, and bringing in the aid of every man towards that end. If the result were a small matter, we might pursue our way, as we did at first, with the fatuous cry, "Business as usual"; but day by day it is brought home to us that the Hymn of Hate, childish though it may seem, really represents the serious mind and deadly intention of our enemy. It behoves us all then who are members of it to show that the British Association, which has rendered such great services to the country in the past, can bear its share of the burden to-day.

I assume that we are all agreed upon this point, and it remains to consider the best way in which such a work can be carried out. Understanding from the president that he is dealing with the question from the point of view of the whole association, I need only deal with the matter so far as it concerns our section. After discussing the matter with our secretary and several of my predecessors in the chair, I suggest that we continue the three research committees already in existence, but do not institute a fresh one, forming instead a special committee, the purpose of which I propose to lay before you. Before doing this, I should like to point out that the very fact that engineering constitutes such an important feature of the war has prevented our having, as often in times past, papers on military and naval subjects, such as warships, armour, projectiles, etc. And this for two reasons: first, because nearly every professional or manufacturing engineer having as a rule sent the best of his staff to the fighting line is overwhelmed by actual work either directly or indirectly connected with munitions and war material, and is much better so employed than in talking about the subject, or even in attending the present meeting; secondly, because men who really know all about such work would not be likely to discuss it in public at the present time, and I am sure you will agree with me that we do not want merely popular science on war subjects.

Hence, the twenty-four papers before the section deal with engineering science generally, but I venture to think they are of a high scientific quality, and quite as important in character as those of former years; and, although I need hardly remark that our report on gaseous explosions does not, as suggested by a daily paper, relate to high explosives, it will be noticed in several cases the papers touch closely on subjects bearing on the war, such as those on wireless telegraphy and the traction of artillery.

The object of the proposed committee is twofold. The first of these would be to undertake any work which may be of use in an advisory capacity or by research, or indeed in any other way for direct assistance in the war. This would, of course, be a temporary object of the committee, but nevertheless a real one. I need not go into all that may be done in this direction by the committee, but one step will be to place ourselves at the service of the Ministry of Munitions for such work.

With regard to the second purpose, the matter stands on a rather different footing. We were in many respects quite unprepared for the war on which

[1] Abriged by the author.

we have entered, and though this offers one of the most powerful arguments in refutation of the charge that we deliberately entered the war for sinister purposes, it will be very disastrous if we repeat our unpreparedness when the war ceases, and we shall deserve the worst that can happen to us. When peace is concluded, it will only be a prelude to another war, and a war which will recommence with far greater energy on the part of our enemy than before—viz., the war of commerce—and the latter will be almost as serious for us as the more sanguinary one.

Remembering how soon we forgot that black December week fifteen years ago; and the lurid indication from the German Emperor that he and his people had the will to destroy us then if not the power, and how swiftly we relapsed into national ease at the end of the Boer War, it behoves every man who can do so to take his share in making ready for the terrific struggle Germany is certain to put up in the arts and manufactures. I might give evidence of this from a number of sources, but I will only take one emanating from a body of professors of the great universities of Germany. These gentlemen have published a voluminous manifesto containing, amongst other gems, the following:—"Once the Russians are driven back beyond their new Frontier we shall not forget the war which England has made on the maritime and Colonial commerce of Germany. That must be the guide of our action and we must supplant the world trade of Great Britain. By her blockade of Germany, England has instructed us in the art of being a European Power, militarily, industrially independent of others. We must immediately seek to create for ourselves apart from the Empire of the Seas a Continental commercial enceinte as extensive as possible." It does not, however, want such published evidence to convince any practical person of the folly of thinking that a keen and virile nation having more than 100 million inhabitants is going to be crushed out of fierce and vengeful competition, whatever the end of the war may be. We shall better appreciate what this competition will mean if we consider the progress made by Germany during the last half-century in the arts and manufactures. (The president then gave curves showing the comparative growth of Great Britain and Germany during the last fifty years.)

The above curves are quite sufficient to illustrate the marvellous progress of Germany; and in passing I may remark that one of the most persistent allegations which has been repeated *ad nauseam* by German statesmen, soldiers, professors, and the whole German Press generally, is that the war is caused by our jealousy of this progress. Perhaps you will consider it waste of time even to allude to this matter; but I will take this opportunity of pointing out that if there had been any truth concerning this jealousy, it would have been the simplest thing in the world to shut Germany out of a large number of markets in the British Empire, and that this would have been a very much cheaper process than going to war. Our Colonies, which are now fighting equally with ourselves against German aggression, made a very small difference (5 per cent., for instance, in the case of New South Wales) in regard to the introduction of German manufactures. I myself have somewhat close knowledge of two colonies, and I cannot help recalling the astonishment with which I found in South Africa that, when there was a huge scheme of electrification effected, the enormous amount of material which Germany supplied was for what the public mostly believed to be a purely British enterprise. I also have reason to know that the supply of machinery to New South Wales from Krupp in some cases exceeded by as much as ten times in amount the quantity supplied by British firms. The prices were no higher, in spite of the 5 per cent. advantage to this country. The delivery of the goods was, on one hand, sometimes inordinately delayed, though scrupulously punctual in delivery on the other.

Now, when we look closely into the causes of Germany's great advance, we can learn lessons which we have been culpably slow to take to heart. Although there are other causes, first and foremost, and overshadowing all others, is the determined and whole-hearted organisation of German industry. I see it recently stated that the scheme above referred to (the Victoria Falls scheme) was lost to this country because the industrial banks of Germany backed their own manufacturers, and this is no doubt partly true. As I have already quoted, Germany's power in war is admitted to be her mechanical organisation, and the organisation of every material and engineering force to that end. Just as striking, if not more so, is her organisation for the arts of peace, and I lately heard a very shrewd man of affairs express his amazement at Germany's entrance into war, when by peacefully pursuing the way she was going she would have dominated the world commercially in a few years' time. It is undoubtedly in the matter of scientific organisation even more than the organisation of science that Germany has achieved such wonderful results, and it is therefore in this direction that we must leave no stone unturned if we wish to have any chance of holding our own in the future. I will indicate a few of the matters in which there is ample scope for doing useful work in the above direction.

Education.

A sign of the times is the inclusion of an Education Section in an association for the advancement of science. This has not been done on the narrow ground of improving the teaching of science in schools, but because it is now recognised, and this none too soon, that the whole problem of education must be treated in a scientific manner.

When the subject of engineering education is mentioned we are apt to think only of the training of such engineers as have been considered in a recent report issued by the Institution of Civil Engineers, and to exclude, as that report purposely does, the training of our artisans and foremen. We certainly do not connect the idea at all with the training of the artisan himself. As a matter of fact, while high scientific training of the professional engineer and manufacturer is of vital importance, the proper education of the men whom he will have to control is scarcely less so. The latter education may not be of the same kind, but it is just as vital to the country, and its present condition is a serious evil.

A well-known American, in the *General Electric Review*, writing on the "individual and corporate development of industry," points out that theoretically the aim of both employer and employee is the same, namely, the efficiency of industrial production to increase the return of the investment in labour and in capital. Unfortunately, however, as he remarks, "the relations between the two have frequently been hostile industrial warfare over the distribution of the returns rather than co-operation for the increase of financial returns of both parties."

One of the most humiliating things of the present war has been the mutual relation of the two in this country in what is probably the most critical period in our history. I will say more later on this subject, but there is no doubt the subject of industrial education needs earnest consideration.

(Various matters connected with the education of engineers were then dealt with.)

Research.

If there is one thing more than another which the British Association can be congratulated upon, it is the work which it has done in the matter of research, and it is very interesting to go back to the earliest days, more than eighty years ago, and to see how, in very different days from the present, research in all branches of science was encouraged, and what a potent factor the various meetings have been, not only in actually fostering the work of research itself, but in obtaining the recognition which is accorded it to-day. Amongst other things, the National Physical Laboratory stands largely to its credit, as having been first powerfully advocated at one of its meetings. This section has not been behind the others, and at the present moment there are three research committees, viz., those on gaseous explosions, compound stress, and impact. The work of the first of these is so valuable that its results have been published all over the world.

To-day there is a more general recognition of the importance of research, and the recent institution by the Government of a Committee for the organisation and development of scientific and industrial research is the latest indication that the nation is beginning to realise its importance.

So far from all this making our work less necessary, there is all the more reason why we should have a permanent Committee of Research, because one of the intentions of the new Government Committee is to utilise the most effective institutions and investigators available, and the statement is made that one of the objects of the Government Research Committee is to select and co-ordinate rather than originate, and that one of its chief functions will be the prevention of overlapping between institutions and individuals engaged in research. The Government Committee in question is only dealing with the organisation in England, Wales, Scotland, and Ireland. Now, the great advantage possessed by this association is the fact that it includes not only Great Britain and Ireland, but all the Colonies, and indeed one of the three researches above-mentioned is being carried out in Australia. Another research of the association is being carried out in Cyprus; and work is also being done in such places as Jamaica and Egypt. It is more important therefore than ever that the British Association work in research should go on, as, since its members are drawn from all parts of the British Empire, its influence should be correspondingly great.

(The president then dealt with various aspects of research specially relating to engineering.)

Standardisation and the Metric and Decimal System.

One of the favourite gibes at this country is our supposed utter want of system in regard to our standards and systems of measurement generally. With regard, for instance, to the decimal system, it is frequently stated that thirty or forty countries have adopted the metric system, while only three retain the inch as a standard. It must be remembered, however, that the population and wealth of the three latter are at least equal to, if not greater than, all the others, though this does really not prove anything, except the difficulty of the subject, and that there is a great deal to be said for both sides. In the report of the Decimal Association last April, the hope is expressed that one of the changes for the better arising from the war will be a reform of our weights and measures. No class of the community would be affected more closely than the engineer, and engineers cannot fail to be interested in the question as to whether the general and immediate adoption of the metric system would or would not be a valuable means of assisting British firms in their competition with Germany and Austria, in countries where that system is in vogue. Although it is very unlikely that a wholesale change is imminent, it is certain that the metric system is gradually spreading, and in the United States and Australia very strong forces are on foot to bring about a change to that system. The British Association has over and over again had the subject before it, and our committee might be of service in making a report on the present state of the matter.

One thing is certain: the committee might be of assistance in recommendations which would bring into line all British engineers in duplicating tenders for countries which have the metric system.

Coming to standardisation, here we have more ground for satisfaction. The Engineering Standards Committee during the last ten years has done a work which is quite equal to that in any other country, of completing standardisation of all important matters in engineering, and, moreover, has secured the recognition of these standards in all public contracts.

There is yet work to be done, however, and one matter of great importance would be to get a universal standard of temperature for instruments of measurement other than zero. A temperature, for instance, of about 62° Fahr. would make steel rods' measures more practically workable than at present.

In connection with the subject of temperature and standardisation, I recently came across a statement by the general secretary of the International Electrotechnical Commission (*Journal*, January, 1915) that the want of uniformity in the rating and testing of electrical machinery has been a serious evil, and he goes on to say:—"The German standardisation rules, for instance, which, through well-organised and combined effort on the part of the German makers, had previous to the war become widely recognised on the continent of Europe as well as in many countries to which British machinery is exported, by permitting a higher temperature rise than is considered good technical practice in Great Britain, certainly have not assisted the British maker in foreign markets."

Exhibitions and Museums.

In recent years a large number of commercial exhibitions have been held of all branches of machinery, and it is satisfactory to note that one of the features of such exhibitions has been the holding of scientific lectures, and the inclusion of the exhibition of scientific instruments and apparatus, and also exhibits showing the relation of scientific experiments to engineering work.

(Here follows a number of practical suggestions on this subject.)

Patents and Patent Laws.

This subject is well worthy of the consideration of the proposed committee, since progress in engineering, certainly on the mechanical and electrical sides, is largely dependent upon invention, which is not likely to be seriously undertaken without adequate protection, not entirely for the inventor, but also for those who really make the invention practical by means of capital and business support. A great deal of nonsense is talked and written about inventors, as if they were a special class of being, generally mad and always impossible. Some inventors are both, but the fact is, most engineers spend their lives seeking new ideas and devising new methods of carrying them out, in short, in inventing. It is of the greatest importance that every step should be taken to encourage sound invention and to see that anything of value is secured for this country. Of course, every invention

worth anything is immediately known in other countries, but I need not argue to this section that the country which actually produces the inventions is at a great advantage quite apart from the royalties payable on foreign patents. The foundation of the Munitions Invention Panel is a step in the right direction and will doubtless be followed later on by Government Committees for peace inventions. Such Committees or Government Departments dealing with various industries will be assisted by suggestions from a body like this. Take, for instance, the present state of Colonial patents; within the last few years one Commonwealth patent has been made to cover the whole of Australia, instead of there being, as of old, separate patents with different regulations and fees for each separate Colony. South Africa has not yet conferred a similar boon upon inventors, and we might do something to expedite this desirable innovation. But this touches the much wider question of Colonial Patent Laws as a whole. These are all different and differ from those of the Mother Country. It would be a splendid thing if we could bring about à conference leading to unification of these diverse Patent Laws and have one comprehensive Patent Law for the whole Empire.

A matter in which the German system has certain advantages, is in having two classes of patents. One of these is the patent "proper," which is only granted after the most severe search and criticism and holds the usual period when granted. The other is a secondary patent granted for the shorter term of six years, and is given for one of the hundred and one minor improvements and devices which, though of real value, only constitute small modifications in detail and not new applications of principle.

(The president stated that he believed German patents were fairly granted to foreign applicants, but the common view to the contrary was supported by such statements as in the prospectus of the Deutsche Maschinenfabrik, which runs as follows:—"With the present-day competition every firm is compelled to protect its new designs by means of patents, *and watch that no other patents are granted* which would seriously effect (*sic* affect) it.")

There are other matters, such as the question of giving wider powers to our Comptroller to refuse a grant where novelty is less than microscopic. Here again the German system of demanding that some definite principle is applied *to produce some definitely new effect*, might to some extent be followed, especially in view of the constant accumulation of published devices, some patented and others not.

I will conclude this section, which is far from exhaustive, by pointing out what a debt of gratitude engineers and others owe to the Patent Office for the manner in which the work of producing illustrated abstracts of all patents has been, and is being, done, and the weekly issue of the *Patent Journal*, but this may be associated with the suggestion that it would be a real convenience if, instead of the delay which often occurs, the abstract appeared at the same time or immediately after the publication of the complete specification.

Organisation.

This, I venture to think, is by far the most important question of any I have raised, and I will go so far as to say that I believe it to be the all-important one, as it practically embraces the others. If you do not agree with me, I feel sure it is because we do not understand the same thing by the word "organisation." When you speak of organisation to most people they immediately seize upon some small feature which may be to them of more immediate interest. It may be the general arrangement of their accounts, their system of store-keeping, of dealing with their workmen, of the sales department, of fifty other minor details. If you take this narrow view of organisation you will, of course, at once say that a scientific man has very little to do with it, and indeed the manufacturer as a rule, thinking of his works organisation, scouts the idea that a man of science can either know or have anything to say about it which is of any value.

Let me therefore take the dictionary definition. To organise is to "arrange or constitute interdependent parts, each having a special function, act, office, or relation with respect to the whole." If we accept this definition, which as a matter of fact we must, there is no question as to the all-important nature of organisation, for you will notice there are two outstanding things. The first "interdependent parts"; and the second their "relation to the whole." Thus the subject of organisation really includes the whole of industry. It includes science and its relation to manufacture. It includes the relations between the employers and employee. It includes the workman, and his attitude towards new devices, labour-saving appliances, and output. It includes the whole question of the supply of raw materials, and even the sale and delivery of the finished article. Taking these different features, is there any doubt that the man of science in this country can hold his own, and more than hold his own, with that of any other? The history of invention is quite enough to give a final answer to this question. Again, the British employer and man of affairs has always shown himself individually in the forefront of enterprise; as for the workman himself, he is admitted, in the matter of intelligence, physical endurance, and skill, to have no superior; while with regard to materials for manufacture, and the power of delivering goods, it need scarcely be said that the British Empire, if we take it as a whole, is the richest country in the world in raw materials, and its means of delivery of its good is expressed by the enormous preponderance of its mercantile marine.

When we come, however, to these interdependent parts and their relation to the whole, it is there that we find the weak joint in the armour. It is in this respect that Germany can teach us a striking lesson in the *arrangement* of these interdependent parts with respect to the whole. From the top to the bottom the whole forces of their industries are so thoroughly organised that they get all that is humanly possible out of the various factors. I do not limit this merely to the wonderful organisation of any works, like Krupps, or the Deutsche Maschinenfabrik, or hundreds of other works, but I include the organisation of all the Government Departments, together with the banks, the railways, and the shipping, so that every facility is afforded for the world commerce of the German Empire.

This co-ordination in Germany is carried out in every industry in a way we generally have little idea of. For instance, the other day at a deputation to the Government, Mr. Runciman remarked that the difficulty of connecting the manufacturers with the commercial staffs in this country is deep-seated, but perhaps not altogether incurable. Further, that the manufacturer must realise what he can get from the universities, and the university must know what the works require. Dr. Forster, the treasurer of the Chemical Society, also said that "the Germans were so imbued with the need of pursuing modern and efficient methods of education, in applying science to industry, that they hold in contempt a country which notoriously neglects such processes": and he attributed this contempt as partly contributory to their cheerfulness in entering into the war with us.

Now while these remarks are undoubtedly true, they are only a part of the truth. The evil is far wider than in any special application, for, as the German knows perfectly well, there are innumerable individual cases of organisation in this country of equal efficiency to any in his country, and he is glad enough to learn from special cases. Let us take one, and I do so because it shows that the man of science is capable of industrial and manufacturing organisation, if he turns his mind to it. I refer to the case of the firm known as Barr and Stroud, Ltd. (A brief account is then given of the organisation of the foregoing works for constructing range-finders.)

Now I do not believe the Germans despise us for our want *per se* of the application of science to industry. I do not think they have much reason to; but what they do despise us for is the want of co-ordination, which I venture to say amounts to positive slackness, which they are keen enough to observe permeating the whole of this country. They see different sections, instead of being united for a common end, quarrelling with each other, filled with mutual suspicion and distrust, with apparently no common bond of union, and whereas the German is proud of the Fatherland, he sees in this country large numbers who seem, either through self-consciousness or ignorance, to be ashamed to mention the subject of the British Empire, or, what is worse, to acknowledge that any love of their country is or could be a mainspring and incentive to strenuous effort.

The other day, Field Marshal von Moltke stated, and there is no reason to disbelieve him, that great as was the storage of ammunition and shells before the war, the enormous demand far exceeded all expectation, and Germany found herself for a time in the same plight as her enemies, but he further stated that Germany's emergence "from this dangerous position was largely due to the extraordinary organisation, which included not merely the adaptation of their factories for munition purposes, but *capacity for work of the people,* and the *patriotic spirit of the German workmen.*"

This brings me to consider what is probably the most serious feature in our national life to-day, which I have already alluded to under the heading of education, viz., the relation of employer and workman. It is hopeless, as long as such ideas prevail which seem to do at present, to think of any sound organisation of our industrial system taking place, because the interdependent parts are not arranged (and can never be arranged until we change radically) with respect to the whole. Now as one who has served an apprenticeship, who has taken his money weekly from a tin box with hundreds of other men, who has been a member of the Amalgamated Society of Engineers (in fact, was working as an engine fitter when a Whitworth scholarship made a college career possible), I am the last man to put this evil down entirely to the working man. I know individually he is just as capable of patriotism as any other class. Get him by himself, even the men whose strikes have caused such despondency in the minds of our Allies, and who have seriously jeopardised the very existence of the country, and you will find (except in the sort of case to be found in all classes of society), that he, as an individual, is willing to make sacrifices, and if necessary to give himself for his country. The truth is that the canker which is eating the heart out of our industrial life is due to an entirely wrong attitude of mind. (Various matters illustrating this point were then dealt with.)

The matter of labour disputes is so serious as to demand plain speaking. It must be admitted that there are many employers and companies which, to satisfy themselves and their shareholders, extort the largest possible dividends and pay the smallest possible rate of wages, and do so apparently without the slightest idea that the men and boys under them are capable of education and personal influence. Can it be wondered then that men under these conditions are willing enough to listen to the orator who merely appeals to their fighting instincts and join in the game of grab as against the employer? On the other hand, strikes have occurred when employers have honourably carried out their obligations and undertakings, and the men have shamefully departed from an agreement made by their chosen leaders, throwing over the leaders the moment they have fancied it to their own selfish interests to do so, and without a single thought of their duty to the community as a whole.

We have recently seen the Prime Minister and other leading statesmen struggling, sometimes in vain, to bring large bodies of men to a reasonable state of mind. Is not this (and I speak without the slightest reference to party questions) a case of Nemesis overtaking us for having in so many cases pandered to the selfish instincts of large bodies of men in order to secure their votes, instead of sternly telling them unpalatable truths?

There was recently an intensely interesting article by the late Prof. Friedrich Paulson, previously professor of philosophy in Berlin University, published in the *Educational Review* of New York. In this article, the subject of which was "old- and new-fashioned notions about education," he pointed out that the whole of our educational system was going wrong, and that we could not escape the conviction that a tendency towards weakness and effeminacy was its chief trait. His three mottoes were: learn to obey; learn to apply yourself; learn to repress and overcome desires; and he remarked with great truth under the first heading:—"He who has not learned to do this in childhood will have great difficulty in learning it in later life; he will rarely get beyond the deplorable and unhappy state that vacillates between outward submission and uproarious rebellion."

Is not one of the first things the reform of our educational system?

One of the tasks to which the British Association might bend its energies with the greatest benefit to the country, is to bring about a reform of our educational system, so that while we do not kill individual enterprise and freedom of thought, which have contributed so largely to the political organisation and constitution of the British Empire, of the value of which we have had such wonderful evidence from our Colonies and Dependencies during this war, we seek to implant in the minds of young and old those ideas of discipline and service to the State, the want of which so seriously threatens the successful organisation of our industrial life.

Conclusion.

In bringing my address to a close I hope I have made it clear that I have had throughout a practical object. Expressed briefly, it is that the service of every agency is wanted for definite work at this crisis, both in the actual war, and afterwards in the war of industry which will be waged with equal intensity in peace time. The British Association cannot be said to have undertaken as a whole a work of this kind, yet one finds a general desire on the part of every member that something should be done. With this object I communicated with the president, and found that both he and such of the officers as could be got in touch with were in entire sympathy with the general proposal, and advised that our section, like that of Economics, should start at once with a committee on

the subject. I have great hopes that such a committee will be formed, but I have no hopes of either our own subcommittee or the committee of the association as a whole doing any good, unless they are prepared with definite suggestions and advice which cannot be ignored and put aside. I have not the slightest faith in the mere formation of a committee which will content itself, let us say, with the mere offer of its services, even to a Government department, and the mere pious expression of certain opinions. If a committee does not want to become ridiculous, it must show that it is in earnest. To show that it is in earnest it must take care that its reports have a practical object, can be at once grasped by overworked Ministers and officials, and are of real value.

Fortunately the British Association is a powerful body with great traditions, and will be listened to if such work is carefully and energetically done. We can at least congratulate ourselves that whatever the evils of the war, the country as a whole has been moved from its usual attitude of self-complacency, and that the numerous new departments and organisations are showing a desire to utilise every force and agency for the service of the State, and to grapple with the great problem of its more efficient organisation. It will be no small work of a British Association committee if it can supply sound ideas and recommendations on the many thorny problems which must be solved. We cannot all of us be, as so many would like, in the fighting line, either in France or the Dardanelles, but we shall be just as deserving of contempt as those who have shirked their responsibilities, if we content ourselves with mere offers of service, and having as we think shelved responsibility by leaving initiative to others, we pass along our way sheltering ignobly behind those men and women who are doing their duty to their country.

SECTION H.

ANTHROPOLOGY.

OPENING ADDRESS [1] BY PROF. CHARLES G. SELIGMAN, M.D., PRESIDENT OF THE SECTION.

IT is impossible to pass to the subject of my address without first referring to the heavy losses which the Teutonic lust of power has inflicted upon our science, no less than upon every other department of humane and beneficent activity. Whatever loss we may yet be called upon to endure there can scarcely be any more regrettable than the death of Joseph Déchelette, whose acknowledged eminence makes any detailed account of his labours superfluous. His valour was no less than his erudition, for though his age exempted him from all military duties, he insisted on taking his place at the head of his old company of Territorials, and was killed last October while leading his men in a charge that carried the line forward 300 yards. We have also to mourn the death of Robert Hertz, a regular contributor to *L'Année Sociologique*, and of Jean Maspero, son of Sir Gaston Maspero, an authority on the Byzantine period and Arabic geography. The other men whose premature death we deplore belong for the most part to that brilliant band of French soldier-explorers to which African ethnography owes so much, and includes Captain René Avelot, whose name will be known to every reader of *L'Anthropologie*.

In my address I shall endeavour to outline the early history of the Anglo-Egyptian Sudan from the point of view of the ethnologist, and thus indicate some of the lines upon which future research may most usefully proceed.

[1] Abridged by the author.

Surprisingly little is yet known of the prehistory of this great area. No implement of river-drift type appears to have been found, and while admitting that this may be due to incomplete exploration, the fact seems of some significance considering the abundance of specimens of this type which have been found on the surface in Egypt, southern Tunisia, and South Africa. With regard to implements of Le Moustier type, I may allude to certain specimens which I have myself collected from two sites, namely, from Beraeis in north-west Kordofan, and from Jebel Gule in Dar Fung. At the former site I found a number of roughly worked unpolished stones. The majority are moderately thin broad flakes, showing a well-marked bulb of percussion, and little or no secondary working; other specimens are shorter and stouter. One surface is flat and unworked, the opposite curved surface shows a number of facets separated by rather prominent crests, all except the central facets sloping more or less steeply to the working edge. In some specimens the crests are sufficiently prominent to give a somewhat fluted aspect to the slope and a crenelated edge, one portion of which often shows signs of having been worn down and retouched. These implements, which I had suspected might have been Aurignacian, were considered by M. Breuil to belong to the Moustierian period, and he referred to the same period and industry some thick, fluted, and engrailed scrapers from Jebel Gule, which I have described as resembling the Palæolithic discs from Suffolk and other localities, as well as some implements of other forms which presented a Palæolithic facies. Besides the disc and Moustierian points, there is one implement which M. Breuil regards as a true, but much worn, *coup-de-poing* of Moustierian age. Whether all these really date from the Moustierian period or not, certain of the specimens from Jebel Gule show a surprising resemblance to South African specimens figured and described by Dr. L. Peringuey as of Aurignacian type, or, in other words, of the Capsien type of Tunisia.

Evidence concerning the later Stone age is furnished by a number of finds made on widely scattered sites; but though no explanation can be offered it should be noted that no stone implement of any kind has been recorded from the Red Sea Province, although it is one of the best known parts of the Sudan, and has been the scene of considerable engineering efforts. This is the more remarkable in view of the geographical features of the country; the absence of forest, the weathered plateaux, the valleys filled with deposits through which innumerable wadis have been cut, all suggest that if stone implements existed some at least should have come to light. Much interest attaches to the distribution of ground-stone axes in the Nile valley. While there is probably no museum with any pretence to an Egyptian collection which has not a number of these, and though they can be bought in almost every curio shop in Cairo, I have been unable to find any record of their discovery in a tomb group or undisturbed burial in Egypt; so that considering the number of prehistoric burials that have been examined, it can be said that they were scarcely if at all known in predynastic Egypt. On the other hand, they are common in Nubia, where a number have been found in predynastic and early dynastic tombs. Many examples have come from Meroë, and I believe that specimens occur on every site of Neolithic date in the Sudan. Moreover, the rock faces on which they were ground have been found both at Jebel Gule and Jebel Geili. We may therefore attribute a southern source to the ground-stone axes of the Nile valley, and in the light of our present knowledge regard them as of Negro origin. This view is sup-

ported by the results of recent work on the prehistory of the Sahara. Gautier, who has devoted much time to the ethnography of the French Sudan, points out, that while at the end of the Neolithic period the northern Sahara had a stone industry characterised by unpolished implements of Egyptian affinities, in the central and southern Sahara the typical implement was the polished axe, and that this was of Sudanese Negro origin. That the boundary of the two provinces, *i.e.* the Berber-Negro frontier, was then some 1000 kilometres further north than it is at present, is in no way opposed to this view. Besides the types already alluded to, Jebel Gule yielded a large number of pygmy implements of quartz, carnelian, and hornstone. These are similar to those found in South Africa and attributed to Bushmen, and there is reason to believe that this industry also existed at Faragab, where the innumerable disc beads of ostrich eggshell were probably bored with more or less worked-up slivers of quartz.

Some mention must be made of the existence of stone monuments of megalithic type in the Sudan, although their number is small and their origin obscure. There is a monolith about two metres high on the plateau overlooking the Khor el Arab near the Sinkat-Erkowit road, to which tradition says Mohammed tied his horse. Another monolith of much the same dimensions has been described and figured by Crowfoot from Isa Derheib, inland from Akik. At present there seems no reason to attribute any great antiquity to these stones; presumably they are connected with the upright stones and "stelai" of Axum. Probably other rude stone monuments will be found in the Red Sea province; indeed, I have heard of such, though the information was never very precise. It is, however, worth noting that typical dolmens do occur in the Madi country in the southern Sudan.

The only rock pictures as yet found in the Sudan are in northern Kordofan. For the most part they are outlined in red or blackish pigment, but a few examples occur chipped on lumps of granite, on the hillside at Jebel Kurkayla in the Jebel Haraza *massif.* These figures are very rough, and the examples reproduced by H. A. MacMichael all represent camels. Drawings with pigmented outlines are found on Jebel Haraza and Jebel Afarit, and from the artistic point of view seem to form two groups. To the first belong rough but spirited sketches of men on horseback, camels, and giraffes. The workmanship of the second group is rougher and much less vigorous; it includes representations of camels, men on horseback, and men marching or dancing, carrying the small round Hamitic shield. This, together with their general resemblance to the "Libyo-Berber" rock pictures of the southern Sahara, indicates a comparatively recent date for these drawings. Moreover, MacMichael notes that the work is faint and indeterminate, and that there is no trace of graving; in other words, the Neolithic tradition has not persisted.

One of the most difficult questions arising in connection with the Sudan is that of ancient Egyptian influence. Its existence may be readily granted, but what of its extent and duration? For while it is a platitude to say that a great and powerful State with a uniform tradition lasting for thousands of years cannot but have influenced the countries on every side, it must be confessed that where history fails the evidence is often extremely difficult to interpret. Every custom which at first sight seems to betoken Egyptian influence must be closely examined, and the evidence carefully sifted, to determine whether it may not have had its origin in the older and more generalised Hamitic culture of northern and eastern Africa. In discussing the value of the data upon which ideas and customs are to be traced back to an Egyptian origin, it is important to remember that general resemblances, either in widely distributed forms of social organisation and belief (*e.g.* matrilineal descent, cult of the dead, etc.), or in widely diffused technical devices (*e.g.* bow and arrow), cannot be admitted as good evidence. Whatever the future may bring, I do not think that in the present state of anthropological science even extreme and unusual beliefs and devices (which at first sight seem so strikingly convincing) should be considered as proof of common influence; otherwise it would be necessary to admit, immediately and without consideration, a cultural relationship between Papua and Central Brazil on the evidence of the phleme-bow, and between England and the Malay States on that of the fire-piston. It is only when there is a considerable consensus of agreement in underlying ideas and (or) in highly specialised customs or devices, that we are justified in considering an Egyptian origin, and even then it is necessary to bear in mind the possibilities of common ethnic origin and of "convergence." It is obvious that under these conditions facts will be differently interpreted, and opinions will vary within wide limits, while new discoveries may at any moment disturb views hitherto regarded as well founded.

Although I propose generally to confine myself to the area included in the Anglo-Egyptian Sudan, yet in considering the question of Egyptian influence in Negro Africa I shall overstep these limits. The records from the Belgian Congo, for example, are more numerous, while recent work in the north-west of Africa has provided material of much value from this comparatively new point of view.

With regard to the mode in which Egyptian influence was exerted on the Sudan there are three main routes along which we might expect to find its traces. The first is southwards along the Nile, the other two are to the west; one route at first following the Mediterranean coast but broadening westward as conditions become more favourable, the other running south-west through the oases and so communicating with Darfur and the Chad basin. Yet another route has been suggested by Sir Harry Johnston, namely, through Abyssinia and Somaliland, presumably reaching them *viâ* the Red Sea. Perhaps it was by this route that the sistrum, still used in the church festivals, reached Abyssinia.

The extension of Egyptian rule up the Nile valley can be traced from the earliest times to the XVIII. dynasty. But although after this Egyptian domination becomes less marked, Egyptian influence had become so firmly established that the culture of the states in the Nile valley had a predominantly Egyptian tinge[2]; first Napata, then Meroë, and then further south the States which we know later as the Christian kingdoms of Dongola and 'Alwah.

On *a priori* gounds the Nile route might be expected to be the most worn and the easiest to trace. For thousands of years Egyptian and Negro were in contact on the middle reaches of the great river, so that at least one great negroid kingdom arose; and though to this day a Negro dialect is spoken as far north as Aswan, yet at the present time there does not seem to be a single object or cultural characteristic which unequivocally can be said to have reached the zone of luxuriant tropical vegetation by way of the Nile valley.

[2] The early Ethiopian kings used the Egyptian language and writing for their records; it was only towards the end of the Meroitic period after the downfall of Egypt, that the Meroitic language was written. A special hieroglyphic alphabet founded on the Egyptian may date back to the third century B.C., but the actual Meroitic script is later than this. Crowfoot indeed argues for so late and short a range as from the middle of the second to the fourth century A.D. (Griffith, "The Meroitic Inscriptions of Shablûl and Karanog," chap. ii.).

The evidence for the earliest spread of Egyptian influence is set forth in the Reports of the Archæological Survey of Nubia. In the reports, Prof. Elliot Smith shows that beyond Aswan, as far south as exploration has proceeded, the basis of the ancient population from the earliest times to the end of the Middle Empire was essentially of proto-Egyptian type, and that this type became progressively modified by dynastic Egyptian influence from the north, and Negro and Negroid influence from the south. As a result, the Nubians contemporary with the New Empire present such pronounced Negroid characteristics as to form a group (the C group) which stands apart from its Nubian and Egyptian predecessors. The recent discoveries made by Prof. Reisner at Kerma in Dongola province show that here was a fort or trading post certainly occupied during the Hyksos period, and probably as far back as the VI. dynasty. It is the remains of the Hyksos period that are especially interesting. Reisner describes a people who razed the buildings of their predecessors, and buried their dead in the débris, who battered the statues of Egyptian kings of the XII. dynasty, and whose funerary customs were entirely un-Egyptian. Each burial pit contains a number of graves in every one of which several bodies had been interred. The chief personage lies on a carved bed; "under his head is a wooden pillow; between his legs a sword or dagger; beside his feet cowhide sandals and an ostrich-feather fan. At his feet is buried a ram, often with ivory knobs on the tips of the horns to prevent goring. Around the bed lie a varying number of bodies, male and female, all contracted on the right side, head east. Among them are the pots and pans, the cosmetic jars, the stools, and other objects. Over the whole burial is spread a great ox-hide." Reisner could not observe any marks of violence, but, judging from the contorted positions of some of the bodies, thought that they had been buried alive. The remains from these burials have been examined by Elliot Smith, who states that the skeletons surrounding the bedstead are those of folk of proto-Egyptian and Middle Nubian (C group) types, while those on the beds belonged to typical New Empire Egyptians, such as lived in the Thebaid at this time.

The first historical capital of the Sudan was Napata, the mediæval Merowe or Merawi, near Jebel Barkal, between the 19th and 20th parallels of latitude, a few miles south of the Fourth Cataract. Napata was certainly an important place in the XVIII. dynasty, but how much earlier is uncertain. In the XX. dynasty the high priest of Ammon assumed the viceregency of Nubia, and there is evidence that during the two succeeding dynasties the priestly families of Thebes set up at Napata a kingdom which, in theory at least, reproduced the theocracy of Ammon at Thebes. The first recorded lord of this new kingdom was Kashta, whose son Piankhi succeeded him about 741 B.C., and by 721 B.C. had conquered and garrisoned Egypt almost as far north as the Fayum. His brother Shabaka founded the XXV. (Nubian) dynasty, which lasted at least fifty years. Thus Napata was Egyptianised, and being a great trading centre cannot but have influenced profoundly the country to the south, so that when Meroe was founded in the eighth century B.C. the ruling influence must have been Egyptian. The mission sent by Nero to explore the Nile reported that Meroe was ruled by a Queen Candace, whose predecessors had borne that name for many generations. Yet, since the monuments show that a king was generally the head of the State, Pliny's assertion requires qualification; moreover, there is the perfectly definite reference to King Ergamenes slaughtering the priests who, as was the custom, had determined his death. In both statements I cannot but see examples of Egyptian theocratic influence. Nor are they mutually destructive if it be remembered that the throne might, and often did, pass in the female line, and that this practice was known to be in full force during the XVIII. and later dynasties. It would be entirely consonant with the policy of the priests of Ammon to take advantage of the spirit of the *sed* festival, the rite of ceremonial Osirification practised by the Egyptian kings, in order to obtain for themselves absolute political control. This would be the easier if among the barbaric tribes in southern Nubia the king was ceremonially killed as he recently was in Fazogli, and as he still is among the Nilotes. Strabo's description makes clear how relatively narrow was the stream of northern civilisation which penetrated Black Africa by way of the Nile valley. But even this civilisation did not come with a steady flow; when Egypt prospered under the early Ptolemies Meroe prospered; as Egypt decayed Meroe fell into the wretched condition recorded by Nero's officers; and even before this Candace could assert that neither the name nor condition of Cæsar was known to her. As northern influence lessened, and the power of Meroe decayed, the black element would preponderate more and more, so that the travellers quoted by Pliny who had actually visited Ethiopia told a story of barbarism and utter stagnation. But even in the earlier and better days when a king exerted real authority at Meroe it would be entirely consonant with African politics and African customs for vassal "kingdoms" to arise at the extremes of the State. So, when it is recorded on the authority of Eratosthenes that in the third century B.C. the Sembritæ who occupied an island south of Meroe were ruled by a "queen" but recognised the suzerainty of Meroe, we may think of the petty chieftains of the eighteenth century who were the true rulers of the country from Dongola to Sennar, though every sultan of Sennar claimed sovereign rights. There may have been many such "states" ruled by women, just as at the present day in the Nuba hills the highest authority passes in the female line, and may be exerted by a woman.

Meroe seems to have been destroyed before the introduction of Christianity. Nevertheless, two if not three culture phases can be traced in its history. There was first a period of Egyptian influence under King Aspelut and his successors, then came an influx of Greek ideas, a phase which Prof. Garstang would date from about the third century B.C. This is the period to which most of the monuments now visible belong, and it was succeeded by the period of Roman dominance. At Soba, on the Blue Nile a few miles above Khartum, Lepsius collected the cartouches of a number of kings and queens of Meroe; this site, the capital of the Christian kingdom of 'Alwah, was certainly inhabited through mediæval times, and may not have been fully deserted till three or four hundred years ago.

No doubt the territory over which the rulers of 'Alwah exerted authority extended south of their capital, yet beyond Soba, in the archæologically unexplored country south of the confluence of the two rivers, traces of northern influence quickly become fewer and less distinct. Nevertheless, at the present day among the hills between the White and Blue Niles the name Soba is still known, being recognised as that of a series of great queens who ruled over a mighty empire of the same name. The Fung or Hameg of Jebel Gule say that the great Queen Soba whom they worship was their ancestress, but they also apply her name to certain rocks which they regard as sacred. A prayer given me by a woman

at one of these rocks ran somewhat as follows: "Grandmother Soba . . . permit us to go on our journey and return in safety." There was obviously the utmost confusion in this woman's mind between Soba the goddess, who may be asked to relieve sickness, and Soba the stone, on which she had just placed a handful of sand. Few will doubt that in the Soba of the Hameg belief there is preserved the memory of such queens as Candace the ruler of the Sembritæ, grafted on the recollection of the great city, which to the Negroids of the Gezira no doubt appeared to dominate the north. Nor do these traces of ancient tradition stand alone; at Jebel Moya near the Blue Nile some 150 miles south of Khartum there is actual archæological evidence of northern influence. Here, besides stone implements, were found beads and amulets, a number of scarabs, and small plaques bearing Ethiopian and Egyptian cartouches ranging from about 700 B.C., or perhaps going back to an even earlier date. I may also note that on the as yet unexplored site of Faragab in northern Kordofan, besides potsherds, stone implements and ivory objects, I have found a carnelian bead, identified by Prof. Petrie as of XVIII. dynasty make, as well as dolomite and scolecite beads which are certainly not of Negro workmanship or character.

These sites seem to mark the southern limit of Egyptian influence as far as the actual transmission of objects derived from the north is concerned. Of the racial affinities of the inhabitants of Faragab nothing is known, but we are better informed concerning the old residents of Jebel Moya. The cemeteries of this site have yielded the remains of a tall coarsely built Negro or Negroid race with extraordinarily massive skulls and jaws. In a general way they appear to resemble the coarser type of Nuba living in South Kordofan at the present day, and it is significant that the cranial indices of the men of Jebel Moya and the Nuba hills agree closely. Thus there is the clearest evidence that Egyptian influence reached south of Khartum, and since it has persisted to the present day in oral tradition among the tribes of the little known country between the Blue and White Niles, traces might equally be expected among the Nilotes of the White Nile. But, strangely enough, nothing of the sort has been found, although the Shilluk and Dinka are better known than any other of the Sudan tribes. On the other hand, the tribes of the Congo basin have a number of customs which do suggest Egyptian influence, and the same may be said perhaps of Uganda, so that it seems reasonable to believe that Egyptian influence spread up the White Nile and passed westwards across the Nile-Congo watershed. An alternate route would be along the Blue Nile and its tributaries, the Dinder and the Rahad, to the Abyssinian hills, southward through the highlands to about 5° N., and thence westward to the head waters of the Congo.

To return to the Shilluk and Dinka, the most northern of the Negro tribes of the White Nile. The fact that no cultural elements which can be connected with Egypt are found on the White Nile, where they might have been expected, suggests either that the tribes now occupying the district were not there when Egyptian influence spread south, or that the country presented such difficulties that the foreign stream left it on one side, as would have been the case had it followed the route *via* the Blue Nile and the highlands of Abyssinia. In other words, either the Shilluk and Dinka reached their present territory in comparatively recent times, or else led a wandering and precarious life in swamps as formidable as the Sudd of the present day. There is, I think, a good deal in favour of the latter view. The existence in the depths of the Sudd of Nuer communities, of which we know little except through rumour, shows that such a life is possible; while among the Dinka the Moin Tain, or "marshmen," who possess no cattle and scarcely cultivate, but live by hunting and fishing, exist under almost as unfavourable conditions. Moreover, there is abundant evidence that North-West Africa is drier now than it was a few thousand years ago, and if those authors are right who state that there was a general melting of glaciers in Eur-Asia some 5000 years B.C., giving rise to widespread floods (the origin of the Biblical deluge), the increased precipitation may well have given rise to a considerable northern extension of the Nile swamps. In support of this argument, it may be noted that in numerous XVIII. dynasty paintings Negroes are represented with bows and arrows and throwing sticks (boomerangs), *i.e.* their weapons are not those of the northern Negroes of the present day, the Shilluk and Dinka, who are not bowmen and do not use the throwing stick. Shilluk traditions state that they came from the south, and a language substantially identical with theirs is spoken by the Acholi of the Uganda Protectorate.

Evidence pointing in the same direction exists on the physical side; the results of the archæological survey of Nubia show that even in late dynastic times the tall Negroids (E-group) whose skeletons have been found near Shellal were mesaticephals, with a cephalic index higher by three or four units than those of the Dinka and Shilluk respectively. On the other hand, a people with a cephalic index nearer that of the northern Nilotes had reached Nubia by the Byzantine-Pagan period (200–600 A.D.). Elliot Smith and Derry speak of these people (the X-group) as prognathous and flat-nosed Negroids who suddenly made their way north into Nubia. Sixteen X-group skulls (eleven male and five female) in the College of Surgeons give a cephalic index of 70·8, and, comparing them with the series of about the same number of Dinka skulls in the collection, my impression is that as a group they show as many Negroid characters.

The numerous records of Negro incursions from the Middle Kingdom onwards suggest that the Negroes were driven north in a succession of waves by some force from which this direction offered the only chance of escape. Such can only have been applied by other Negroes behind them. It may well be that there was more or less continual ferment on the southern border of Egypt in the early part of the first millennium B.C., and that the northern Nilotes were beginning to make their reputation as fighting men. Indeed, the passage in Isaiah can scarcely bear any other meaning than that this people was working north with sufficient energy for their peculiarities and those of their land to have become known to the Mediterranean world. "Ah, the land of the rustling of wings, which is beyond the rivers of Ethiopia: that sendeth ambassadors by the sea, even in vessels of papyrus upon the waters, saying, Go, ye swift messengers, to a nation tall and smooth, to a people terrible from their beginning onward; a nation that meteth out and treadeth down, whose land the rivers divide!" (Isa. xviii. 1, 2, Revised Version). But while the tall Negroes seem to have been the first to reach Nubia in organised groups, stray examples of short brachycephalic Negroes (usually female) have been found as far back as protodynastic times. I am indebted to Prof. Elliot Smith for the information that the four Negresses found in cemetery No. 79 at Gerf Hussein were short in stature with relatively broad oval crania, while at Dabod in a Middle-Kingdom cemetery there was found a skeleton of a

man measuring 1·61 m. (about 5 ft. 3 in.), with definite prognathism, typical Negro hair, and a cephalic index of 80. Presumably these were representatives of the group of short mesaticephalic Negroes who are at the present time found on both sides of the Nile-Congo divide, but predominantly west of it, a group represented by the Bongo, Azande, and cognate tribes. We thus reach the position that the Nubians, who were proto-Egyptians, were, in the earlier part of their history, in contact with just that class of Negroes among whom customs and ideas apparently of Egyptian origin are found at the present day. It must not, however, be assumed that it was this contact that led to the dissemination of Egyptian ideas; indeed, our present information suggests that it can scarcely have been sufficiently intense.

The following table, giving the measurements and indices available for the comparison of the E-group Negroids with the tall Negroes of the present day, shows that the former belonged to the mesaticephalic group, which includes the Burun, the Bari, and the Nuba. As regards head length, head breadth, cephalic index, and stature, the E-group stands closer to the Nuba than to the other tribes, while even in head breadth it is as near the Nuba as the Dinka.

	H.L.	H.B.	C.I.	Stature
Shilluk ...	195	139	71·3	1776
Dinka ...	194	141	72·7	1786
E-group ...	190[3]	143[3]	75·68[3]	1723
Nuba ...	190	145	76·6	1722
Burun ...	190	150	79·16	1759
Bari ...	190	149	78	1741

At the present day the mesaticephalic group includes the Hameg and the Berta of the hills between the White and Blue Niles. The excavations at Jebel Moya—also between these two rivers—have enabled Dr. Derry to show that in Ptolemaic times this hill stronghold was inhabited by tall mesaticephali with a cephalic index almost identical with that of the Nuba, so that we are led to conclude that all these tribes, including the E-group Negroids, belong to one and the same stock.

A number of similarities between ancient Egypt and modern Africa have been set out recently by Prof. Petrie. He does not discuss the routes by which Egyptian influence may have reached Negroland, but simply marshals the evidence of similarity under sixty-one headings. A good many of these are so widely spread outside Africa as to be of little evidential value; others, and this applies specially to material products, include such simple or obvious devices that they can scarcely be regarded as carrying weight; but there are a number of instances which are highly suggestive, and when to these are added yet other habits and customs common to ancient Egypt and Negro Africa, a mass of evidence is presented which seems decisively indicative of Egyptian influence. This view does not imply that all the features common to ancient Egypt and present-day Negroes are instances of borrowing; on the contrary, I hold that many common customs are but expressions of the wide diffusion of old Hamitic blood and ideas. To this ancient stratum I would attribute those customs which I have discussed in a previous paper, including burial by the Nilotes in the crouched position, the use of the throwing-stick (boomerang) by the Beja, and the killing of the divine king (or rainmaker).

The ideas and customs reported from tropical Africa which may be due to Egyptian influence may be classified provisionally in the following groups, though the space at my disposal here permits only a brief reference to the third group:—

(i) Beliefs connected with the soul.

(ii) Beliefs and customs connected with the king or the royal office.

(iii) Death customs.

In Egypt the body was prepared for the grave by an elaborate process of mummification; it was then enclosed in a coffin, often of anthropoid shape. In tropical Africa numerous instances of attempts to preserve the body are recorded. In Uganda the body of the king was opened, the bowels removed, emptied, washed in beer, dried, and then replaced, while among the Banyoro and the Makaraka other methods were adopted. It seems a far cry from the mummies of Egypt to the smoke-dried corpses of Equatoria, and it is not difficult to see that ancestor worship might easily give rise to attempts to preserve the body when everyday experience would suggest desiccation or smoking, but there are certain Congo tribes whose practices do suggest an actual link with Egypt. Among the Wambunda of Stanley Pool the body is placed in the squatting posture, the limbs are tightly flexed on the body and tied in that position, the whole being packed with a large quantity of spongy moss which is kept *in situ* by bandages. A gentle fire is kept up round the body for two or three months, after which it is rolled in native cloths and buried. The latter part of this ceremony hints that the attempts to preserve the corpse may have been imposed on an older habit of speedy burial; such an imposition could only have come from without.

Among the Wangata an important person of either sex is buried in a massive coffin with a lid carved to represent the deceased. It is difficult not to believe that here is an echo of the Egyptian mummy case. If this be so, may not the practice of a tribe near Lake Leopold II., who, after a rough preparation of the body, roll it in native cloth and place it in a canoe-shaped coffin, be regarded as connected with the funerary boats of Egyptian burial ceremony? Since the anthropoid coffin was unknown before the XI. dynasty, it follows that the northern influence must have been exerted after this period. Egypt's first great expansion (after the pyramid builders) dates from the XII. dynasty, when Egyptian and Negro were in intimate contact at the Second Cataract, as shown by the celebrated decree of Senusert III. Further, about this time special importance seems to have been attributed to the funerary voyage on the Nile, indeed, almost all the models of funerary boats in our collections are of this period.

If these facts be accepted as evidence of the date at which Egyptian ideas influenced equatorial Africa, there are other customs which seem to indicate that this was not the only period of such cultural drift. The coffins of the III. and IV. dynasties were often large rectangular boxes designed and painted to represent houses. Now the Mayumbe roll the body of a dead chief in layers of cloth and place it in an enormous wooden coffin of rectangular shape, the top of which is carved to present a homestead. Again, the funeral ceremonial of the Ndolo seems reminiscent of this period. Immediately after death the Ndolo prepare the body, painting it red, touching up the eyebrows with charcoal, and propping it up with open eyes and mouth on a high seat in the very posture of the *ka* statues of the pyramid-builders, *i.e.* seated with the forearms and hands upon the thighs, a position which I venture to say no Negro would adopt. The body remains here for a day, while more or less continual drumming and dancing go on, and is then buried.

[3] The H.L. and H.B. of the E-group skulls have been increased by 7 mm. and 8·5 mm. respectively in order to make these measurements comparable with those on the living. For the same reason the C.I. has been increased by 2 units.

The form of an Egyptian mastaba tomb was to a very great extent the expression of the Egyptian belief that the soul, or souls, of the deceased visited the body in the tomb chamber, coming in and out by the shaft of the pit, and indeed the XVIII. dynasty papyrus of the priest Nebqed represents the human-headed *ba*-soul descending the shaft to visit the mummy. These beliefs also led to the burial of supernumerary stone heads to which the soul might attach itself should the body perish. Recently eight life-size portrait heads of a princess and the courtiers of the court of Chephren have been found in the mastabas at Gizeh constituting the royal cemetery of the fourth dynasty. The cartonnage busts, presumably of the deceased, represented as carried in funeral processions of the Middle Empire, are probably a development of the same idea. Similar expressions of belief—perhaps most obvious in tomb construction—occur in Negro Africa, the examples being too numerous and the resemblances too exact for this to be due to any other cause than actual borrowing.

To sum up: concerning the early prehistory of the Anglo-Egyptian Sudan we have no more than indications. In the Neolithic stage, which appears to have persisted until a comparatively recent date, Negro influence, if not predominant over the whole area, was at least powerfully felt even in the north, as is shown by the distribution of polished axe-heads. But against this northward pressure must be set the continual extension of Egyptian culture, the evidence for which may best be found in the eschatological ideas and burial customs ("mummification" and anthropoid coffins) of the peoples of Equatoria. This influence, which seems to have persisted until medieval times, may have reached tropical Negroland as early as the Middle or even the Old Kingdom. Nor was the Nile route the only one by which Egyptian influence was spread. Another and later drift extended westwards, as shown by the coinage of the north African States, which enables us to fix its date within fairly precise limits. We do not know how far south this drift travelled, but it seems certain that it reached at least as far as the Senegal River and the great bend of the Niger.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

LONDON.—Prof. J. A. Fleming will give a public introductory lecture at University College, on "Science in the War and after the War," on Wednesday, October 6, at 5 p.m. This lecture will be open to the public without fee or ticket. Other free public lectures are as follows:—On October 6, at 2 p.m., Photographic Surveying, by Mr. M. T. M. Ormsby; on October 7, at 2 p.m., The History of Tools, by Prof. W. M. Flinders Petrie, and at 5 p.m., Final Causes in Animal Psychology, by Mr. Carveth Read; on October 8, at 5 p.m., The Physiological Action of Light, by Prof. W. M. Bayliss, and at 5.30 p.m., Steam Turbines, by Mr. W J. Goudie; on October 11, at 3 p.m., Racial Frontiers in Central and South-eastern Europe, by Prof. L. W. Lyde; on October 12, at 5 p.m., An Investigation of the Heating of the House of Commons, by Mr. A. H. Barker; and on October 29, at 5 p.m., The Applications of Electric Heating, by Prof. J. A. Fleming.

The University Officers Training Corps, under the command of Lt.-Col. D. S. Capper, will begin its eighth year of training under exceptional conditions, as the colleges of the University are largely depleted of students. In the infantry unit, the largest in the contingent, the training since the outbreak of the war has been mainly of a continuous character, cadets being accommodated in premises near London. As a rule, a few months of training under these conditions have been sufficient to qualify cadets for commissions. The artillery and engineer units of the contingent are also in active training. Their work is especially important at the present time, as there are so few facilities for the training of technical officers. The artillery unit has been permitted to keep its guns and equipment for training purposes. In the medical schools of the University, a considerable number of students are completing their medical training with a view to taking commissions as soon as qualified. The strength and training of the medical unit of the University O.T C. have therefore not been much affected by the war, and the cadets attended camp as usual. Since the outbreak of war, the number of commissions obtained by cadets and ex-cadets of the contingent up to the end of August, 1915, amounts to 1521, and 189 commissions were obtained before the war, giving a total of 1710. In addition, 245 commissions have been obtained, up to the same date, upon the recommendation of the University, by graduates and students who were not cadets or ex-cadets of the University O.T.C. Before the end of September, the University will have supplied well above 2000 officers to the Army through the O.T.C. or by direct recommendation, and many other graduates and students have obtained commissions through other channels. Distinctions obtained by ex-cadets of the University O.T.C. include:—Military Cross, 6; Medaille Militaire, 1; Mentioned in Dispatches, 14. Under War Office Regulations, membership of the University of London O.T.C. is not restricted to members of the University, and other men of suitable education desirous of qualifying for commissions are accepted Candidates for enrolment should apply personally to the Adjutant at the Headquarters, 46 Russell Square, W.C.

MR. W. CALDWELL, of Trinity College, Dublin, has been elected professor of chemistry and professor of physics in the Schools of Surgery of the Royal College of Surgeons in Ireland.

IN July last the Federation of University Women offered a prize fellowship of 80*l.* to 100*l.* for original work published by women. We learn that the fellowship has been awarded to Miss M. Wheldale, Newnham College, Cambridge.

THE new session of the School of Pharmacy of the Pharmaceutical Society will open on Wednesday, October 6, when the inaugural address will be delivered by Sir Rickman J. Godlee, and the Hanbury gold medal presented by the president.

THE will of the late Mr. George May, mining engineer and colliery proprietor, of Darlington, bequeaths 500*l.* to the North of England Institute of Mining Engineers, the income to be applied in providing "George May" prizes for students, and 500*l.* to Armstrong College, Newcastle, to found a "George May" scholarship in mining.

THE London County Council has arranged for the undermentioned free public lectures to be given at the Horniman Museum, Forest Hill, S.E., at 3.30 p.m. on Saturday afternoons, commencing on October 2: The folk-lore of Russia, Mr. Edward Lovett; the Belgian Congo, its peoples and its animal life, Rev. J. H. Weeks; Rumanian history and folk-lore, Mr. A. R. Wright; (1) our Western Allies, (2) our Eastern Allies, Dr. A. C. Haddon; the folk-lore of France, Mr. E. Lovett; Japanese history and folk-lore, Mr. A. R. Wright; (1) flies as enemies of man, (2) the dangerous parasites of man, Mr. H. N. Milligan; S. Sophia,

Constantinople, and the mosques of Constantinople and Brusa, Prof. F. M. Simpson.

THE calendar of Birkbeck College, London, for the present session has been issued. The arrangements made for the session, which is the ninety-third, are as complete as in previous years. The general character of the educational work provided by the college is summarised in the Final Report of the Royal Commission on University Education in London (1913); the Commissioners write:—"We think that the original purpose of the founder of Birkbeck College and the excellent work that institution has done for the education of evening students who desire a university training, mark it out as the natural seat of the constituent college in the Faculties of Arts and Science for evening and other part-time students." In addition to the university courses arranged in science, arts, laws, and economics, classes will be held in commercial and other subjects.

THE British Fire Prevention Committee's "Fire Warnings" have been before the public from time to time in connection with the war emergency, but the different forms of "Fire Warnings" available and the extent to which they can be obtained gratuitously does not appear to be generally known. Among the "Fire Warnings" obtainable in poster form, printed in red, 8 ins. wide, are the following—the reference number must be given in all communications regarding them:—For elementary and secondary schools: *re* air raids (No. 20); for public schools and boarding schools: *re* air raids (No. 20*a*); *re* fires due to air raids (No. 17): for householders, etc.; *re* fires due to air raids (No. 17*a*): as to dealing with incendiary bombs, etc. Local authorities and school committees —as also headmasters or headmistresses—requiring "Warnings" No. 20 and 20*a* (for schools) will receive a suitable number of copies free upon written application to the registrar, giving the full name and postal address of the institution for which they are required, the number of pupils, subject to their enclosing a large-sized, addressed, and properly stamped envelope for despatching the necessary posters. All communications should be in writing addressed to the Registrar, the British Fire Prevention Committee, 8 Waterloo Place, London, S.W. More than a quarter of a million posters has already been issued by the committee gratuitously.

THE educational and social announcements for the present session at the Northampton Polytechnic Institute, Clerkenwell, London, have been issued in the form of an attractive calendar. The only new evening class which has been arranged is a "Glassworkers'" evening course, which is being jointly undertaken by the technical optics and the technical chemistry departments. The class is required urgently at the present time, owing to the disturbance in this particular trade caused by the war. Notwithstanding the war, the equipment of the various departments was extended during the session 1914–15. In the mechanical engineering department, the testing equipment was increased by the addition of a Heenan and Froude dynamometer, and the prime mover equipment by a semi-Diesel engine. In the electrical engineering department, various transformers and motors of special types were added, and a Tirrell regulator and a mercury arc rectifier were installed. The instrument equipment was also extended. In the technical optics and other departments, a fair amount has also been spent on extensions. The courses in the Engineering Day College are to be continued, but the second- and third-year courses, which extend ordinarily from September to Easter, are in 1915–16 to commence in January and to be continued until July. This arrangement will enable the students to work up to Christmas in the munitions workshop, which has been employed in making gauges and parts of armaments during the whole of the summer vacation. The special classes for Post Office workmen and boy messengers, started two years ago, are being continued, as are also those in submarine cable work for the employees of the cable companies who have their headquarters in London.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 30.—M. Ed. Perrier in the chair.—The president announced the death of Emile Guyou, member of the Academy.—G. **Humbert**: The reduction of Hermite forms in an imaginary quadratic body.—D. **Pompeiu**: A double solution of Riccati's equation.—B. **Mayor**: A correspondence between articulated systems of space and those in a plane.—M. **Gibon**: New methods in stereo-radioscopy. Radioscopic methods are more rapid than radiographic methods, and three processes of stereoradioscopy are described. The first process makes use of two Crookes's tubes, with a metallic diaphragm placed between the bulbs and the patient, a stereoscopic image being formed on a platinocyanide screen.—P. W. Stuart **Menteath**: Some fossils of the Pyrenees.—J. **Pescher**: Respiratory gymnastics and its therapeutic effects. Drawings of the instrument are given, and its use and mode of application are described. Cases are cited in which its systematic employment has given beneficial therapeutical effects. —Edmond **Bordage**: The differences in the appearance of adipose tissue produced by hystolysis in certain Orthoptera.

September 13.—M. Camille Jordan in the chair.—G. **Bigourdan**: Astronomical observations made in France before the foundation of the Academy of Sciences and the Observatory of Paris. An account of the work of early French astronomers up to the sixteenth century.—A. **Chauveau**: Diffuse inflammation of the forearm resulting from a previous general infection.—Paul **Vuillemin**: Essential differences between the nasturtium and the Geraniaceæ. Tropæolum differs fundamentally from the Geraniaceæ in the position of its nectaries and in the typical number of stamens. The author considers it necessary to re-establish the family of Tropælaceæ.—MM. **Tuffier** and **Amar**: Walking-sticks and crutches. Scientific model of a supporting cane. This is designed to prevent forms of paralysis frequently resulting from the use of ordinary crutches.—B. **Galitzine**: The direct measurement of accelerations. A continuation of an earlier paper on the same subject.—A. **Portevin**: The decomposition of potassium cyanate by heat. The reaction $KCN+O=KCNO$ is reversible, potassium cyanide being formed by heating potassium cyanate, in proportions ranging from 20·9 per cent. at 700° C. to 48·9 per cent. at 900° C.—E. Kohn **Abrest**: An arrangement for rapidly testing substances used against poisonous gases. The results obtained with various absorbents for chlorine are tabulated. The solutions containing sodium bicarbonate were not so effective as those with sodium carbonate. Sodium thiosulphate alone gave off SO_2, but in admixture with excess of sodium carbonate the absorptive power was good. Solutions of potassium iodide gave very complete absorption.— Léon **Gizolme**: The influence of the algæ of sand filters on the chemical composition of water. The amount of dissolved oxygen was found to increase and the alkalinity to diminish with increase of sunlight.

Curves are given showing the change in the dissolved oxygen and in the alkalinity with the time of day, and one curve is the exact inverse of the other. These results are attributed to the development of the chlorophyll activity of algæ.—J. **Tissot**: The most favourable conditions for the rapid cicatrisation of wounds. Recent work by Dakin and Carrel aims at the production of a slightly toxic, strongly antiseptic, and non-irritant solution for treating wounds. The author holds that the irritating action of such solutions is essential to their curative action, and shows that various accepted methods of treatment, either physical or chemical, are based on their irritating action. Although the antiseptic properties of alkaline hypochlorites are very high, their favourable action is regarded as being less the result of their bactericidal effects than to their stimulating or irritating effects on the tissues.—M. **Marage**: The treatment of deafness resulting from wounds in war. An account of the results achieved by the application of the methods proposed in an earlier communication. Two-thirds of the cases were able to return to the front as cured.—J. **Rodhain**: The biology of *Stasisia rodhaini*.—E. **Roubaud**: The production and autodestruction of domestic flies by horse manure.

September 20.—M. Ed. Perrier in the chair.—J. **Boussinesq**: Remarks and calculations showing that the complication of the formulæ for large displacements of deformable bodies is due, not to the deformations, but to the rotations.—Wilfrid and Conrad **Kilian**: A reef formation containing stromatospores in the Urgonian of Chamechaude (*massif* of the Grande Chartreuse).—Edouard **Heckel**: The transmission by seeds of the effects of castration in maize stems. It has been shown that one effect of male castration in maize is to increase the amount of sugar in the stems. This has been carried out for four successive years, and it has now been proved that this increased proportion of sugar in the stems can be transmitted by the seeds.—Pierre **Humbert**: The bifurcations of Jacobi's ellipsoids.—C. **Camichel**: Hammering in pipes; oscillations in mass.—Jules **Andrade**: Chronometric methods for the measurement of the terrestrial magnetic field. A magnetised needle is connected with the balance wheel of a non-magnetisable chronometer in such a manner as not to interfere with the equilibrium with respect to the axis of rotation of the balance wheel. The theory of the determination of the magnetic field from the rate of the chronometer is developed, and it is shown that a high accuracy can be obtained.—Jean **Pougnet**: The action of ultraviolet light upon solutions of mercuric chloride and upon some mercury salts. Solutions of mercuric chloride are rapidly decomposed by light from a mercury vapour quartz lamp, calomel being deposited. The reaction is to a certain extent reversible, since calomel suspended in water and submitted to the ultraviolet rays gives some mercuric chloride. Many slats of mercury are also shown to be affected by the same treatment.—R. **Chudeau**: Atmospheric pressure in western and equatorial Africa.—Jean **Mascart**: Description of a localised storm.—B. **Baillaud**: Remarks on the preceding paper.—A. **Moutier**: The troubles of arterial circulation under war conditions. All the subjects returning from the battlefield present a radial hypotension. Other circulatory troubles are frequently observed locally in the neighbourhood of wounds. Treatment having for its aim the regularisation of the arterial circulation will aid conservative surgery and will sometimes remove the necessity for amputations.—A. P. **Dustin**: The method of experimental parthenogenesis of Delage and its mode of application.—A. **Brachet**: The cyclic evolution of the cytoplasm of the fertilised egg.—Mlle. A. **Raphael** and V. **Frasey**: The toxin of the septic vibrion and the corresponding antitoxin. The septic vibrion give in twenty-four hours a very active toxin, which can be easily and rapidly titrated on the rabbit. The immunisation of the horse against the poison can be made rapidly and without danger. The serum thus obtained shows antitoxic and anti-infective properties when used on laboratory animals both against the septic vibrion and *Bacterium chauvoei*.—Em. **Bourquelot** and A. **Aubry**: The biochemical synthesis of the α-monoglucoside of ordinary propylene glycol with the aid of α-glucosidase.

WASHINGTON, D.C.

National Academy of Sciences (Proceedings No. 9, vol. i.).—Alice C. **Fletcher**: The Indian and Nature. Glimpses are given of the line the Indian pursues in his endeavour to express his view of Nature and of the relation he believes to exist between its various forms and forces and himself.—Jacques **Loeb**: The mechanism of antagonistic salt action. The author studies the effect of the concentration C of the salt at the external surface of membranes in addition to the concentrations $C_{,}$ and $C_{,,}$ of the salt outside and inside the membrane, and finds that $C_{,,,}$ is serviceable in explaining the mechanism of antagonistic salt action in certain cases.—Chas. B. **Lipman**: The nitrogen problem in arid soils. A summary of some recent investigations and field manifestations with reference to their bearing on problems of soil fertility in California.—F. H. **Seares**: A notation for use in the discussion of star colours. The extension of absolute scales of photographic and photovisual magnitudes to the fainter stars provides a method of determining the colours of objects at present beyond the reach of spectroscopic investigation, and it is convenient in the statistical discussion of such colour results to introduce a notation similar to that used for spectral classification. The letters *b*, *a*, *f*, *g*, etc., are used to correspond to *B*, *A*, *F*, *G*, etc.—F. H. **Seares** and H. **Shapley**: Condensation, colour, and magnitude in star clusters. Neither N.G.C. 1647 nor M 67 show any dependence of condensation upon colour which cannot be explained on the basis of included background stars; there seems to be little, if any, dependence of condensation upon magnitude, but there is a marked relation between colour and magnitude in N.G.C. 1647, and a less pronounced relation in M 67.—H. S. **Uhler**: Thiele's "phase" in band spectra. The author outlines an interpolation method for determining c in the formula $\lambda=f[(n+c)^2]$, which is much simpler than using Thiele's complicated formula.—E. G. **Conklin**: Why polar bodies do not develop. The second or internal factor in normal fertilisation is a non-diffusible substance which is introduced by the spermatozoon, and it is strongly suggested that this factor is the sperm centrosome, a position which Boveri has long maintained, and which the author has hitherto contested. Giant polar bodies do not develop because they are not fertilised, and they are not fertilised because they are generally formed after a spermatozoon has entered the egg and has rendered it impervious to other spermatozoa.—W. W. **Campbell** and J. H. **Moore**: Radial velocities of the planetary and irregular nebulæ. The fact that the gaseous nebulæ have motions which are characteristic of the stars, and their concentration in the Milky Way, indicate that these nebulæ are members of our stellar system. The great velocities of the nebulæ in the Magellanic Clouds and other considerations lead to the hypothesis that the Magellanic Clouds are isolated cosmic units with no apparent connection to our own stellar system.

CALCUTTA.

Asiatic Society of Bengal, September 1.—Rai **Monmohan Chakravarti** Bahadur: Notes on the geo-

graphy of Orissa in the sixteenth century. The author attempts to discuss in this paper all the geographical information available about Orissa in the sixteenth century. His main authorities are the *Mādalā Pāñji,* or the Chronicles of Jagannatha Temple in Puri (Orissa), and the *Aine-i-Akbari* of Abul Fazal. This information is checked and supplemented by information available at the time of the early British occupation, and obtained by personal inquiries made during his service in Orissa for thirteen years.

BOOKS RECEIVED.

L.M.B.C. Memoirs on Typical British Marine Plants and Animals. XXIII. Tubifex. By G. C. Dixon. Pp. viii+100+vii plates. (London: Williams and Norgate.) 3*s.* 6*d.*

Practical Organic and Bio-Chemistry. By R. H. A. Plimmer. Pp. xii+635. (London: Longmans and Co.) 12*s.* 6*d.* net.

On the Relation of Imports to Exports. By J. T. Peddie. Pp. v+88. (London: Longmans and Co.) 2*s.* 6*d.* net.

The Birth-Time of the World, and other Scientific Essays. By Prof. J. Joly. Pp. xv+307. (London: T. Fisher Unwin, Ltd.) 10*s.* 6*d.* net.

Elementary Photo-Micrography. By W. Bagshaw. Third edition. Pp. 143. (London: Iliffe and Sons, Ltd.) 2*s.* 6*d.* net.

Lord Kitchener and his Work in Palestine. By Dr. S. Daiches. Pp. 88. (London: Luzac and Co.) 2*s.* 6*d.* net.

Flora of the Upper Gangetic Plain and of the Adjacent Siwalik and Sub-Himalayan Tracts. By J. Duthie. Vol. iii., part i. Pp. 168. (Calcutta: Superintendent Government Printing, India.) 1*s.* 10*d.*

Germany's Violations of the Laws of War, 1914–15. Compiled under the auspices of the French Ministry of Foreign Affairs. Translated by J. O. P. Bland. Pp. xxxviii+343. (London: W. Heinemann.) 5*s.* net.

A Manual of Mechanics and Heat. By Prof. R. A. Gregory and H. E. Hadley. Pp. viii+309. (London: Macmillan and Co., Ltd.) 3*s.*

The Essentials of Illustration. By T. G. Hill. Pp. xii+95. (London: W. Wesley and Son.) 10*s.* net.

Qualitative and Volumetric Analysis. By W. M. Hooton. Pp. 86. (London: E. Arnold.) 3*s.* net.

Smithsonian Institution. Bureau of American Ethnology. Bulletin 46: A Dictionary of the Choctaw Language. By C. Byington. Edited by Dr. J. R. Swanton and H. S. Halbert. Pp. xi+611. (Washington: Government Printing Office.)

The New Psychiatry. By Dr. W. H. B. Stoddart. Pp. iv+67. (London: Baillière & Co.) 3*s.* 6*d.* net.

Papers from the Geological Department, Glasgow University. Vol. i., 1914. (Glasgow: J. MacLehose and Sons.)

Birds and Man. By W. H. Hudson. New edition. Pp. 306. (London: Duckworth and Co.) 6*s.* net.

The Foundations of Normal and Abnormal Psychology. By Dr. B. Sidis. Pp. 416. (London: Duckworth and Co.) 7*s.* 6*d.* net.

Child Training. By V. M. Hillyer. Pp. xxxix+299. (London: Duckworth and Co.) 5*s.* net.

Birkbeck College Calendar, 1915–16. Pp. 134. (London.) 3*d.*

Manuals of Chemical Technology. III. Industrial Nitrogen Compounds and Explosives. By Dr. G. Martin and W. Barbour. Pp. viii+125. (London: Crosby Lockwood and Son.) 7*s.* 6*d.* net.

The Solar Eclipse of August 21, 1914. By C. Størmer. Pp. 6+iv plates. (Kristiania: J. Dybwad.)

A Manual of the Chikaranga Language, with Grammar, Exercises, Useful Conversational Sentences and Vocabulary. By C. S. Louw. Pp. x+397. (Bulawayo: Philpott and Collins.) 12*s.* 6*d.* net.

Wales: Her Origins, Struggles, and Later History, Institutions, and Manners. By G. Stone. Pp. xxxvi+455. (London: G. G. Harrap and Co.) 7*s.* 6*d.* net.

Documents Scientifiques de la Mission Tilho (1906–1909). Tome Troisième. Pp. vii+484+plates. (Paris: E. Larose.)

DIARY OF SOCIETIES.

MONDAY, OCTOBER 4.

SOCIETY OF ENGINEERS, at 7.30.

WEDNESDAY, OCTOBER 6.

ENTOMOLOGICAL SOCIETY, at 8.—Contributions to the Life-histories of *Latiorina pyrenaica*, *Agriades escheri*, and *Scolitantides arion*: Dr. T. A. Chapman.—The Life-history of *Lycaena arion*: F. W. Frohawk and Dr. T. A. Chapman.

THURSDAY, OCTOBER 7.

EUGENICS EDUCATION SOCIETY, at 5.15.—Eugenics and the Doctrine of the Super-man: Prof. J. A. Lindsay.

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Editorial and Publishing Offices:

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THURSDAY, OCTOBER 7, 1915.

PRACTICAL ENGINEERING.

(1) *Plain and Reinforced Concrete Arches.* By Prof. J. Melan. Authorised Translation by Prof. D. B. Steinman. Pp. x+161. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1915.) 8*s.* 6*d.* net.

(2) *Masonry: A Short Text-book on Masonry Construction, including Descriptions of the Materials used, their Preparation and Arrangement in Structures.* By Prof. M. A. Howe. Pp. ix+160. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1915.) Price 6*s.* 6*d.* net.

(3) *Railroad Field Manual for Civil Engineers.* By Prof. W. G. Raymond. Pp. vii+386. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd, 1915.) 12*s.* 6*d.* net.

(4) *Working Data for Irrigation Engineers.* By E. A. Moritz. Pp. xiii+395. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1915.) 17*s.* net.

(1) "PLAIN and Reinforced Concrete Arches" is an American translation by Dr. Steinman of a German treatise by Prof. J. Melan, who is an authority on structural design, and has invented a well-known system of reinforced arch construction. The treatise is thorough, accurate, and clear. After considering the theory of hinged and hingeless arches, the latter by both analytic and graphic methods, the effects of temperature, displacement of the abutments, and non-vertical loads are examined. Then come arches with elastic abutments, the results being applied to a treatment of arches continuous over several spans, on lofty piers. Reinforced arches are next considered, and there is a valuable chapter on the recalculation of the stresses in an arch ring by a more rigorous method after it has been provisionally designed. The calculations of arches, especially of reinforced arches, are laborious, and fully-worked-out examples of two actual bridges are given, the solutions being in one case by analytic, in the other by graphic, methods. There is a very useful chart for designing concrete sections with double reinforcement.

Prof. Melan has written several books on arched construction, and this one appears to be a condensed but fairly complete statement of the present state of arch theory. In investigating the critical conditions of loading for each arch section, the method of influence lines is used with great advantage. For abbreviating labour in provisional designing, easily applied simple approximate expressions are found. In many cases of double reinforcement the steel bars in compression are understrained. To obviate this, Prof. Melan has invented the method of putting them into an initial condition of thrust by loading them with part of the weight of the centring. The economy obtained is of value, and the method has been adopted abroad, though it is probably little known here. The treatise is very practical, if that can be said of a theoretical treatment of the subject, and can be strongly recommended to any engineer concerned in designing concrete arched bridges.

(2) "Masonry," by Prof. Howe, is an elementary, mainly descriptive account of stone masonry, brickwork, and concrete construction, not including reinforced concrete. Quarrying and manufacturing operations are briefly described, and the different kinds of brick and stone masonry, mass and block concrete, and tools used in different operations. The cement gun is described, used for giving a dense surface finish to mass concrete by blowing a cement grout against the surface.

(3) "The Railroad Field Manual," by Prof. Raymond, consists almost entirely of tables required in surveying and laying out curves. Its peculiarity is that the centesimal in place of the sexagesimal division of angles is adopted. The author remarks that, in practically every railway curve problem, it is necessary at some stage of the solution to transpose from minutes and seconds to decimals of a degree or *vice versâ*, and that it would require much less mental labour to lay out sub-chords if the transit were divided decimally, and, of course, if suitable trigonometrical tables were available. The tables seem to have been carefully arranged and to be accurate. Of course, if the author's method is to be used, the verniers on any transit made as at present would have to be altered to read hundredths of a degree, but this is not a very serious matter. Only experience can prove whether the economy of labour is sufficient to make the change desirable.

(4) "Working Data for Irrigation Engineers" consists in the main (*a*) of hydraulic diagrams and tables giving discharge of canals, pipes, orifices, and weirs; (*b*) of structural diagrams and tables giving earthwork quantities, bending moments on beams, tables for reinforced concrete and timber, etc. Large use is made of graphic diagrams. Some of the information is derived from the records of the U.S. Reclamation Service. The author is competent, and the book will be of service to irrigation engineers.

G

BOTANY AND GARDENING BOOKS.

(1) *Whitby Wild Flowers: A Complete Botanic List of the Flowers, Grasses, and Ferns of the Whitby District (including Levisham and Scarborough), with Notes on their History and Habitats.* By B. Reynolds. Pp. 60. (Whitby: Horne and Son, 1915.) Price 1s.

(2) *Field Book of American Trees and Shrubs: A Concise Description of the Character and Color of Species Common throughout the United States, together with Maps showing their General Distribution.* By F. S. Mathews. Pp. xvii+465. (New York and London: G. P. Putnam's Sons, n.d.) Price 7s. 6d. net.

(3) *Experimental Plant Physiology for Beginners.* By L. E. Cox. Pp. vii+111. (London: Longmans, Green and Co., 1915.) Price 2s. net.

(4) *Elementary Studies in Plant Life.* By Prof. F. E. Fritsch and Dr. E. J. Salisbury. Pp. xv+194. (London: G. Bell and Sons, Ltd., 1915.) Price 2s.

(5) *Climbing Plants.* By W. Watson. Pp. x+132. (London and Edinburgh: T. C. and E. C. Jack, n.d.) 2s. 6d. net.

(6) *Plant Life.* By C. A. Hall. Pp. xi+380. (London: A. and C. Black, Ltd., 1915.) Price 20s. net.

(1) THIS little book gives a useful list of the flowering plants of Whitby and its neighbourhood, including notes on the interesting alien forms which there, as elsewhere on our coasts, are endeavouring, often with success, to become naturalised. It aims also at interesting the holiday visitor in the attractive flora of the district, about half of the book being devoted to excursions in search of wild flowers with the author as pleasantly helpful and gossipy as a leader of such excursions should be. The arrangement of the book is somewhat loose and rambling, and misprints are somewhat numerous and occasionally a little puzzling, such as "Schlerochia" for "Sclerochloa."

(2) The author has packed into this book on American trees and shrubs an astonishing amount of information, with well-arranged and lucid descriptions and a wealth of illustrations both plain and coloured. The appendix contains numerous maps showing the distribution of a large number of species, three or four species being usually shown on each map, together with other useful charts (geological, soil, altitude, etc.). It is much to be wished that a book on similar lines were available dealing with British trees and shrubs, published at an equally moderate price, in such handy form, and with such excellent figures showing details necessary for identification of the species.

(3) This thoroughly practical little book, though limited in scope and dealing only with part of the subject of plant physiology, is about the best of its kind that we have seen. The directions for experimental work with simple materials and apparatus more than make up in clearness what they lack in novelty, and the beginner who works through the experiments will certainly have nothing to unlearn on proceeding to a more extended study of plant physiology. It seems a pity that some work on movement in plants, other than tropisms, was not included; even the beginner for whom the book is intended ought to know from experiment that plants can perform movements of greater agility than those involved in growth responses to such factors as gravity and one-sided illumination.

(4) This little book is apparently in the main a condensed and simplified version of the same authors' "Elementary Studies in Plant Life," and it presents the same excellent features—clearness of description, abundance of good illustrations, and a just appreciation of the importance of physiology and ecology in the study of the elements of botany. It would not be easy to find a book better suited to the needs of junior students.

(5) The name of Mr. William Watson on the title-page of a gardening book is a sufficient guarantee of the accuracy of its contents, and this handy volume on climbing plants is a most welcome addition to gardening literature. The claims and possibilities of climbers are admirably dealt with by Mr. W. Robinson in a wise and witty introduction, and the book certainly ought to stimulate interest in the culture of this somewhat neglected class of plants. No fewer than one hundred genera, many of them with several species, are dealt with by Mr. Watson in his usual precise and helpful manner; valuable hints are given as to the selection and cultivation of hardy, greenhouse, pergola, tree, and other climbers; the systematic notes are arranged in alphabetical order under the genera; and there are twenty-four excellent plates, eight of them coloured. These beautiful and wonderfully cheap "Present-day Gardening" volumes are worthy of a more durable kind of binding; few would grudge paying a little more if necessary in order to have something more substantial than the cardboard backs, which get badly rubbed and cracked in a short time even with careful use.

(6) The author's attempt at the compilation of a "popular botany" is somewhat more ambitious than usual in the case of such works, and certainly more successful so far as accuracy is concerned. We have little doubt that those who can

afford to buy a somewhat expensive book, and probably many will be willing to lay out twenty shillings on a handsome volume with fifty fine coloured plates, will agree that it serves admirably the twofold object of its existence, namely, usefulness to the amateur botanist and an easy introduction to the study of more technical works. The author has evidently selected from a tolerably good modern botanical text-book such parts as are amenable to popularisation and has presented the facts in a simple style, somewhat marred by an extensive use of unnecessary tags and phrases.

It would be easy to criticise various portions, but bearing in mind the difficulty of writing a thoroughly satisfactory book of this kind and the unpretentious objects aimed at by the author, it may be enough to say that it is one of the most attractive books of the kind we have seen. The coloured plates, from drawings by Mr. C. F. Newall, are remarkably fine, being accurate alike in colouring and in structural detail, but we should have liked to see a larger proportion of them devoted to the flowerless plants, especially as the considerable portion of the text dealing with these constitutes one of the best features of the book. The concluding chapter, dealing with ecology, is rather feeble, and will, we fear, give the uninformed reader a somewhat inadequate idea of the methods used and results obtained in this branch of botanical study; but we have not yet seen anything approaching a satisfactory "popular" account of what writers of books of this kind appear to have agreed to designate "the new botany," though as understood by them it is certainly neither new nor interesting, but merely a hotch-potch of "wonderful adaptations," or of obvious remarks about different kinds of plants growing in different kinds of positions, the reader being supposed to infer that until quite recently nobody ever noticed such astonishing facts as that moorland plants do not grow in salt marshes and *vice versâ*!

F. C.

NEW METHODS AND OLD.

(1) *A Campaign Against Consumption: A Collection of Papers Relating to Tuberculosis.* By Dr. A. Ransome. Pp. viii+263. (Cambridge: At the University Press, 1915.) Price 10*s.* 6*d.* net.

(2) *A Chaplet of Herbs.* By F. Hine. Pp. xv+168. (London: G. Routledge and Sons, Ltd., n.d.) Price 2*s.* 6*d.* net.

(1) THE author, whose work relating to tuberculosis is well known, has done well to bring together the various papers he has contributed on the subject. The book is divided into four sections. The first, of a general character, deals with consumption, its causes and prevention, and the duties of the State in regard to tuberculosis. The second section discusses the conditions of infection in tuberculosis. Section iii. gives a summary of the author's researches on tuberculosis, such as treatment of pulmonary disease by means of intrapulmonary injections, media for the cultivation of the tubercle bacillus, etc. The last section is mainly statistical, and discusses such subjects as "The Public-house as a Source of Phthisis," "The Prospect of Abolishing Tuberculosis," and "Phthisis Rates."

Dr. Ransome considers that there is a fair prospect of abolishing tuberculosis, considering that the disease is steadily declining, which must be attributed to an inherent weakness of the microbe at the present time, and that we now possess potent weapons with which, when fully put into action, we may fairly hope to accomplish the final conquest of the foe. The author was optimistic enough in 1899 to suggest that another thirty years should see its vanishing point!

Altogether, much valuable matter has been brought together in this volume.

(2) This little volume of extracts is calculated to give leisure moments of real delight. The author has collected them from old herbals ranging from the eighth to the eighteenth century, and more particularly from those of the golden age of herbalists, 1450–1650. She has shown in her choice of extracts a sympathy and a humorous appreciation which are very attractive; a vein of laughter and delight runs through the book, with kindly charity and gentle raillery for the light-hearted, inconsequent old herbalist. In the introduction is an appreciation of the genuineness, and withal, the quackery, of the herbalists, their weakness for a far-fetched recipe, and their child-like trust in Mother-Earth, dear Dame-Nature.

Here are some extracts:—

"If anyone has over-eat himself, or drank too much; as feasts and pleasing company will lead the wisest into this mistake sometimes, Polypody is the best remedy. . . ."

"To make a woman shall not eat of anything yt is set on the table. . . . Take a little green Basil, and when ye dishes are brought to ye table put it underneath them. . . ."

Remedies for the green sickness and for "Chincough" (hiccough) are enlightening, and involve a pleasant use of alcohol; while thyme helps agues, hickup, lethargy, frensie, megrim, colick, convulsions, melancholy, and resists poison.

We have reason to be grateful for the names of flowers alone, cowslip or paigles, chickweed

or gromel, and flag, gladen, or water-segg for the wild iris.

There is throughout the book a sense of pungent fragrance as of a bunch of herbs, and the "chaplet" is, as the quoted foreword claims, indeed "not short in savour."

R. & L. H.

OUR BOOKSHELF.

The Analysis of Non-Ferrous Alloys. By F. Ibbotson and L. Aitchison. Pp. vii+230. (London: Longmans, Green and Co., 1915.) Price 7*s.* 6*d.* net.

AT such a time as this, when there is a large demand for metals and metallic alloys of all descriptions, it is of the greatest importance that the manufacturers and users of these materials should have at their disposal rapid and accurate means of controlling the chemical composition of the goods they handle.

Until comparatively recently the "commercial" chemical analysis of non-ferrous alloys has received but little attention, at any rate from those most concerned, so that one has been forced to go for one's information to a series of widely scattered original papers in the various scientific and technical journals. A text-book embodying all the best of the information at present available is therefore exceedingly welcome.

The work under review may be divided broadly into three parts. The first part enters into a detailed description of the most recently devised apparatus for electrolytic analysis, and discusses the main theoretical considerations underlying the successful deposition of the metals.

The second part reviews the action of sulphuretted hydrogen on solutions of the metals under varied conditions of acidity, temperature, concentration, and time. Then follows an exhaustive description of the best methods for the estimation of the various metals in solutions of their salts.

The remainder of the book is devoted to the application of the foregoing methods to the analysis of brasses, bronzes, "white metals," and other alloys of industrial importance.

The value of the book is enhanced by a very complete bibliography. The book should prove of great value to works chemists and to the more advanced students in technical schools.

B. W. DRINKWATER.

Science of Dairying: a Text-book for the use of Secondary and Technical Schools. By W. A. G. Penlington. Pp. viii+260. (London: Macmillan and Co., Ltd., 1915.) Price 2*s.* 6*d.*

THIS volume covers a very wide range, and is intended to be used as a text-book of dairying in secondary and technical schools. It deals first with the composition and properties of milk, and gives particulars of the methods employed in the detection of adulteration. Two chapters are devoted to bacteria and the important part they play in dairying. A later chapter gives working details of the two best known rapid methods for the estimation of fat in milk. The first of these—the Babcock test—is not employed commercially in Great Britain, but is common in Australia, New Zealand, and Canada, whereas the second test—the Gerber—is universally practised in this country.

The principles, and outlines of the practice, of butter- and cheese-making are given in a clear and concise manner. The author then passes on to consider the physiology, feeding, care, etc., of the cow, and some of the common diseases to which she is subject. A chapter deals with arithmetical problems arising in dairy practice.

The book is written apparently for those who take up dairying more as a subject of examination than as an end in itself, and it is a little difficult to see to what class of English readers it will especially appeal. Without question, the educational value of such a work is considerable, but as dairying as a subject is not generally taught in the secondary schools in this country, the demand would appear to be limited to those attending a county dairy school, particularly those who are not following a systematic course of training. In the latter case the details are insufficient, but as introductory to the subject all students—whether short or long course—would benefit by a study of the book.

The Internal Combustion Engine: a Text-book for the Use of Students and Engineers. By H. E. Wimperis. New and revised edition. Pp. xvi+319. (London: Constable and Co., Ltd., 1915.) 6*s.* 6*d.* net.

SINCE the first edition of this book was published in 1908, there have been many important developments, both scientific and practical, in the internal combustion engine. These developments have necessitated many changes and additions in the present volume. The book is divided into three sections, the first of which treats of the theory of the subject. After describing the more elementary theorems in thermodynamics and the cycles employed, the author gives a very good account of the numerous experiments which have been made on explosions in closed vessels, and on temperatures inside the working cylinder. The second section deals with gas engines and gas producers, and includes information regarding the Humphrey gas pump, gas turbines, and Hopkinson's water-injection system. Methods of testing and of reducing test results are also given. The third section deals with oil and petrol engines and contains a good discussion on the Diesel engine, and on petrol engines for motor-cars and aircraft.

The illustrations are very good and clear. At the end of each chapter is given a number of excellent exercises, many of which have been taken from recent Cambridge examination papers. The book is very well adapted for the use of students, and has the merits of being moderate both in size and price.

Elementary Photo-micrography. By W. Bagshaw. Third edition. Pp. 143. (London: Iliffe and Sons, Ltd., 1915.) Price 2s. 6d. net.

SOME idea of the scope of this volume may be gathered from the fact that about ninety of its pages, which are not very large, are devoted more especially to photo-micrography, and rather more than thirty to photography—that is, developing and printing. The author takes it for "granted that the reader is already familiar with the use of the microscope," and also presumably that he is an amateur photographer, and seeks to show how the two may be brought together without the need for expensive appliances, and furnish results which, "though not perfect, are good and acceptable for nearly all purposes." He succeeds not only by precept but also by example, giving twenty-nine good reproductions of photo-micrographs taken by the simple means that he describes, using only objectives supplied with students' microscopes. These examples are illustrative of the methods dealt with in the text, and include magnifications from 2 up to 4000 diameters, the use of transmitted light, reflected light, a combination of the two, dark ground illumination, the use of polarised light, oblique illumination, illumination by flashlight, multiple-colour illumination, and a photograph on an autochrome plate. They are of excellent quality, including even a photograph of *Bacillus subtilis*, ×1000. But the *Amphipleura pellucida*, ×4000, shows that such simple methods will not serve for an extreme test, although taken by means of a one-twelfth immersion lens of 1·4 N.A. and an oiled-on condenser. By the way, such an objective and condenser scarcely come within the range of "students'" microscopical apparatus. In giving "pre-war" prices for chemicals, perhaps the author expresses his faith in an early return to peace conditions.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Masses of Heavenly Bodies and the Newtonian Constant.

IN a well-known treatise on physics we find the following statement:—"By the third law of Kepler we are led to the conclusion that the same value of G (the Newtonian constant of gravitation) applies to the sun and all planetary bodies." This conclusion appears to be fallacious, as we see by the following elementary considerations:—

(1) Take the case of Poynting's famous balance experiment for determining G. The attraction of the large mass M on the small mass m at distance d is

$$\text{couple} = G_M . Mma/d^2 = m'gl' \quad . \quad . \quad . \quad (1)$$

where m', l' are the mass of the balancing rider and its displacement necessary to counterpoise the gravitative pull of M on m.

Equation (1) gives G_M, for we know all the other factors. The suffix used here denotes that the "constant" G_M only applies to a mass if its temperature is that of M.

(2) The earth's attraction on mass m is

$$mg = G_E . Em/R^2. \quad . \quad . \quad . \quad . \quad (2)$$

where E, R are earth's mass and radius respectively.

Equation (2) gives us $G_E . E$. The earth's mean temperature may be, say, 4000° C., whereas that of M above is, say, 15° C. We have no experimental knowledge that the Newtonian "constant" is the same at 15° as at 4000°. Hence we cannot write $G_M = G_E$ and obtain from equation (2) the earth's mass. It is thus evident that the values commonly given for earth's mass and mean density are based on the unwarrantable assumption that $G_M = G_E$. Thus it is quite possible (for we have no evidence to the contrary) that $G_E = 2G_M$, in which case the earth's mean density would work out to be 2·76 instead of 5·52, as generally accepted.

(3) When we come to the case of the revolution of the earth and other planets round the sun, we have similar considerations to the above. Let two planets have mean radial distances d_1, d_2 and periodic times t_1, t_2, we obtain in the form of Kepler's third law

$$G_S . S = 4\pi^2(d_1^3/t_1^2) = 4\pi^2(d_2^3/t_2^2) = 4\pi^2 k,$$

where S = sun's mass and G_S the Newtonian constant for the sun's temperature, whence we obtain $G_S . S$; as we know Kepler's constant k. We do not know S alone, for we may not write $G_S = G_E = G_M$.

Thus we see that the masses and densities of all heavenly bodies, including the earth, are based on an assumption for which there is no experimental support, and which (considering the great range of temperature involved) is probably false.

In the case of the sun, the stars, and all the major planets the mean temperature is certainly as high as four figures, and in many cases probably five figures, on the Centigrade scale. It is thus inconceivable that any laboratory experiment will ever be made to determine the values G_S, G_P, or even G_E. But it is not unlikely that sure experimental evidence will be forthcoming as to the value of G, say, up to 500° C.

I have recently concluded a long research on the value of G up to 250° C., and I have found an increase in that "constant" of about 1 in 10^5 per 1° C. The full results I hope to publish shortly.

No doubt it has been for the sake of simplicity that astronomers and physicists have assumed constancy in G, and have thus obtained the accepted values for mass and density. But in reality these values (by analogy with the terminology of radiation) are not the mass and density, but the *effective-mass* and the *effective-density* respectively, and would only be true-mass and true-density if $G_S = G_E = G_M$, etc. If any temperature effect, such as is mentioned above, can be firmly established, then these terms ought to be adopted in the interests of accuracy.

So far, for simplicity, we have considered the temperature effect of gravity on the large mass only and have ignored any effect on the small mass. In equations (1) and (2) we have the small mass m at ordinary temperatures, say 15° C., so that we have not to consider temperature effect in connection with it. But in equation (3) the two planets in question may differ in temperature. Even then the equation is correct as it stands, supposing (*a*) the temperature effect on a mass considered as one member of a gravitative couple is identical with (*b*) its effect on mass considered as so much inertia; for these terms (*a*) and (*b*) occur on the left and right sides of the equation and cut out. But, on the other hand, if (*a*) is not identical with (*b*) the equation would have other factors. But neither in this

case nor in the other can the equation (3) be made to prove the quoted statement with which this article begins.

Although the above considerations are theoretically of profound importance, they will obviously have no influence whatever on astronomical calculations; for in all such calculations the product of mass into Newtonian constant is used. Suppose in the case of the sun $G_S > G_M$ and let S, S′ be the true sun's mass and its present accepted value, then

$$G_S . S = G_M . S'.$$

In no calculation do we require S alone, but always product $G_S . S$, so that the false values for the sun of G_S and S do not lead to error.

P. E. SHAW.

University College, Nottingham.

The Spectrum of X-Rays.

(1) KOSSEL (*Verh. d. D. Phys. Ges.*, 1914), discussing the previous measurements of the frequencies of the corresponding lines of the spectrum K and L characteristic for different elements, as well as of the limits of the respective bands of absorption, established certain numerical relations among them which Wagner (*Ann. der Physik*, 1915) confirmed in a more perfect way and even generalised. In addition, the extremely precise measures of Bragg and Pierce (*Phil. Mag.*, October, 1914) for the lines K_α, K_β, K_γ in the Ag, the Pd, and the Rh give additional confirmation.

From among these relations, attention is specially directed to the one obtained by generalising the second law of Kossel—

$$L_\alpha = K_\beta - K_\alpha, \text{ viz., } (1)\ M_\alpha = L_\gamma - L_\alpha$$

In these equations each term expresses the frequency of the lines. With its help we can foresee the frequencies of the principal lines of the spectrum of the M characteristic if L_γ and L_α are known.

If we admit Bohr's model for the atom as modified by Kossel—that is to say, supposing that in the transit of an electron from one ring to another a quantum is emitted, the frequency of which is determined by Bohr's formula, the radiation M will correspond to the transit of an electron from the fourth to the third ring, and the corresponding frequency,

$$\nu = \nu_0\left(\frac{1}{3^2} - \frac{1}{4^2}\right)\left(N - a\right)^2 = 1.59 \times 10^{14}(N - a)^2$$

will be emitted.

To demonstrate the exactness of this prediction, I have calculated the values of ν contained in the following table by means of the formula (1), starting from the values of L_α and L_γ given by Moseley, Rutherford, and Andrade. The last row contains the values of ν obtained from the formula—

$$(2)\ \nu = 1.39 \times 10^{14}(N - 21.8)^2$$

deduced by graphic interpolation, where N is the atomic number of the element.

	N	ν cal. by (1)	ν cal. by (2)
Pd	46	81×10^{15}	82×10^{15}
Ce	58	189	182
Eu	63	245	236
Ta	73	364	365
Pt	78	438	440
Au	79	452	455
Radium B ...	82	501	505

As can be seen, the formula (2), of similar type to those found by Moseley for K_α and L_α, shows well enough the change of M_α with N, and besides the constant $1{\cdot}39 \times 10^{14}$ coincides with the theoretical value $1{\cdot}59 \times 10^{14}$, between the limits to be expected on account of the method of calculation. No data are at present available to test this hypothesis. The spectrum M is most likely to be observed in heavy elements and in the radio-active bodies.

(2) In the numerical relations obtained by Kossel and Wagner, there does not appear the groups L_{α_2}, L_β, and L_δ of the spectrum L, nor does there seem any simple way of introducing them in another series of formula involving the frequency of the K radiations. This suggests the possibility of the spectrum being composed of two distinct parts, which might be illustrated by supposing that two rings are situated in distinct planes, from one of which (the one corresponding to L_2) no electron can pass to the ring K. The correctness of this hypothesis could be tested by investigating experimentally the lines of the L spectrum that accompany the spectrum K—a study that does not seem impossible.

It is logical to suppose that this group L_2 should be accompanied by others, M_2, N_2, . . . in the exterior spectrum, and even that in these should appear some new ones—M_3, N_3 . . . N_4 . . . In this way it would be easy to understand how the spectrum gets more and more complicated from the X-ray spectrum to the visible, and even the existence of the well-known series in the light spectrum.

B. CABRERA.

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Studies of the Cotton Plant.

I SHOULD be sorry if any reader of NATURE were to be prejudiced against perusal of my book on applied plant physiology, called "The Development and Properties of Raw Cotton," by thinking that I had attempted to write on the systematic botany of Gossypium. Yet this impression might easily obtain, since your reviewer devotes exactly two-thirds of his review to a few pages of my first chapter, the title of which, "The Development of Pedigree," is alone sufficient to indicate that it was not intended for biologists.

Still, technological treatment is no excuse for inaccuracy, even as enthusiasm for herbaria is no excuse for such a phrase as "peripatetic Mendelian cross-breeding of undetermined stocks." Therefore I would direct your reviewer's attention to the fact that my description of Gossypiæ as a sub-order (instead of a tribe) is taken from an accepted authority on systematy.

He states that "the results and evidences of systematic botany" with regard to cotton have been before us for a long while; the Hindi weed-cotton to which he purposely refers is a sad example of the result. I regret being obliged to mention it, but he misspells it as "Hindu" weed, and then objects strongly to my leaving it with such a loose designation. Now, in the first place, this name is on record in Sir George Watt's standard monograph of the genus, and is therefore as definite as any other. Possibly more definite, for though the specimen used for that determination came from a pure strain, Sir G. Watt called it "a ferine hybrid possessed of a strain of *G. vitifolium*." Only by enlisting the aid of "peripatetic" Mendelism can one justify the apparent contradiction, but nothing *a priori* can excuse the inclusion of this Hindi weed in the "fuzzy-seeded cottons" during the primary division of the genus in that monograph. There is no cotton which has a more naked seed than Hindi.

It is clear that I took too much upon myself in attempting to persuade the growers and spinners of

cotton—in the first dozen pages of the book—that the systematic botany of cotton had some definite meaning. Nor did I think that any reviewer would be so ruthless as to drag my little jest (about scientific names appearing to be "merely useless duplicates of easier names") out of its context to pelt me.

W. LAWRENCE BALLS.

Little Shelford, Cambridge, September 16.

MR. LAWRENCE BALLS's objections to my review of his book, "The Development and Properties of Raw Cotton," which appeared in NATURE of August 26, call for a reply from me.

I feel quite sure Mr. Balls need have no fear that my remarks will be viewed, by even the most casual reader, as the criticisms of a work that had attempted to deal with the systematic botany of Gossypium. But Mr. Balls's anxiety that that great sin should not be attributed to him, exposes himself to the charge of deliberate disregard for both the methods and results of the systematist. It is a fact that I specially devoted a considerable part of my remarks to what I regard as the weak side of Mr. Balls's book, and I repeat it is a very weak side, which, though contained in one chapter mainly, dominates his entire studies of the cotton plant. But with equal deliberation, however, I recognised and even extolled the meritorious features of the book, which are undoubtedly very great.

The implication that I read only certain portions of Mr. Balls's book is quite uncalled for. As a matter of fact, I read every word. It was only because I appreciated and even admired the book that I felt it incumbent to express my mind unhesitatingly. It was in no spirit of carping that I gave special attention to its shortcomings. The issue at stake is very great indeed; namely, the development of the cotton staple, a problem of Imperial interest in the agriculture and industry of our Empire. I cannot help repeating, therefore, that for Mr. Balls to attempt to justify Mendelian cross-breeeding of undetermined stocks (and even pedigree selection of such stocks) of Gossypium is not only a blemish but a serious blunder, both in his book and his work. With culture experiments accuracy, in the starting point (more especially with stocks that of necessity involve several species and numerous varieties and races), is more essential than even care in subsequent treatment. We have heard far too much of the assumption that successful stocks can be produced in the laboratory or the experimental plot, in utter disregard of systematic botany.

The sneer that has been thereby cast on herbaria work is uncalled for, and merits the severest condemnation. Such an attitude may enlist the sympathy of the ignorant, but can secure no advancement in the object in view. The question of the future supply of cotton to the British looms is too serious a matter to justify any half-measures. The history of cotton is full of fads and fancies. Extravagant and wasteful experiments have taken the place of rational development. We have failed because we have not followed nature with sufficient closeness. We require the earnest endeavours of the experimental physiologist to be combined in the closest association with the most extended and searching investigations of the systematist. Either alone must of necessity be useless.

Mr. Lawrence Balls informs us that his description of "Gossypiæ" as a sub-order (instead of a tribe) had been taken from "an accepted authority on systematy." He might have favoured us with the name of the author in question. I have searched through a fairly extensive botanical library and failed to discover the authority to whom he may be alluding. Bentham and Hooker, in their "Genera Plantarum," place Gossypium in the tribe Hibisceæ (which Mr. Balls renders as Hibiscæ), but they make no mention of a sub-order "Gossypiæ" (? Gossypeæ). These are no doubt trivial criticisms and are made only in the spirit of "Hindu" and "Hindi." But admitting the "accepted authority on systematy," is there any advantage in setting on one side the universally accepted authorities on British botany?

I am afraid Mr. Lawrence Balls simply tries to obscure the main issue, raised in my review, by citing an example of careless orthography; the "Hindu" and "Hindi-weed" already mentioned. Is it necessary to explain that the word "Hindu" denotes the people or the religion, while "Hindi" and "Hindustani" indicate the languages of certain portions of India? These are their most general acceptations, but neither could, strictly speaking, be used as the name of a plant, more especially when *that* plant never could have come from India. The person who first used that name, in its Egyptian signification, was very possibly a follower of the school that seems to hold the view that accuracy in systematic botany was an unpardonable offence. De Candolle, long years ago, told us that the aim of science was not to make names, but to use names to distinguish plants. Does "Hindi-weed" isolate a certain cotton plant from all others? If it does not, it is a vulgar name that should find no place in a scientific publication.

Sir George Watt's "Wild and Cultivated Cotton Plants of the World" (to which Mr. Balls refers us) mentions Hindi-weed as being possibly a recessive hybrid of the *Moqui* of Arizona, or perhaps rather of the *N'dargua* cotton of Senegal. It is not advanced as a name that can be accepted as distinguishing a definite plant. But Mr. Balls himself is quoted by Sir George (*loc. cit.*, p. 182) as holding that Hindi-weed "hybridises with the others and the Mendelian splitting forms from the cross are very common, and also go under the name of 'Hindi,' though they are usually very tall, up to three metres. 'Hindi' itself is about one metre high, and except in its seed reminds me of American Uplands." We are thus told, by an advocate of non-systematic studies, that "Hindi-weed" may assume numerous forms and conditions until a certain example of it might have to be spoken of as not being Hindi-weed. Thus that vulgar Egyptian name is by no means as "definite as any other," though Mr. Balls in another passage assures us that it is. It is a loose, popular name that could never be taken seriously as the name of a cotton plant. The issue raised by Mr. Balls as to the Hindi-weed having a naked seed, while he seems to affirm that Sir George Watt "during the primary division of the genus" places it with fuzzy-seeded forms (a passage I have failed to discover) is, however, outside the scope of a review of Mr. Balls's book.

Lastly, I admit that Mr. Balls's jest of scientific names being merely useless duplicates of easier names was not only feeble (as he now admits it to have been) but highly misleading and utterly out of place.

THE REVIEWER.

THE KARAKORAM EXPEDITION.

THE account of Cav. Dr. F. de Filippi's expedition of 1914–15 to the eastern portion of the Karakoram range, briefly noticed in NATURE of August 5, has now been published in the *Geographical Journal* (vol. xlvi., No. 2), with a selection from the beautiful photographs taken by Capt. Antilli, to whom this part of the varied and

important work undertaken by the expedition was entrusted, together with a report of the interesting discussion which followed the reading of the paper. By the kind permission of the Royal Geographical Society we are now enabled to reproduce two of the views exhibited at the meeting on June 14, illustrating the characters and surroundings of the Remo glacier, which in some respects appears to resemble the great ice streams of the Arctic regions rather than those of the usual Himalayan type.

In general the Himalayan glacier, like that of the Alps, is confined to a single drainage system, and is separated from its neighbours by an ice-free ridge. But here we see the Remo not only spilling over the saddles which surround its upper basin, into the valley of the neighbouring Siachen glacier, but actually sending a tongue across the main watershed dividing the Indus drainage from that of Central Asia (Fig. 1). Again, the fact noticed by Dr. de Filippi, that the front of the Remo glacier is almost free from moraine matter, is without parallel among the larger glaciers of the Himalaya, where one may often clamber for miles beyond the snout over heaped-up masses of débris, and scarcely detect a vestige of the ice beneath. The moderate dimensions of the mountains that rise above the Remo glacier, as compared with its breadth, no doubt account for its immaculate appearance, so vividly described in the paper (Fig. 2).

The difference in aspect between the surroundings of the Remo glacier and those of the glaciers further west and in Sikkim, a point raised by the President at the close of the discussion, is perhaps to be explained in part by the geological structure of the district. The line of division between the crystalline rocks constituting the main axis of the Himalaya and the softer slates, shales, and limestones of Palæozoic and Mesozoic age which succeed them on the north, is shown on Lydekker's geological map of Kashmir (Memoirs, Geological Survey of India, vol. xxii.) as passing diagonally across the Karakoram range to the west of the Siachen glacier; and in the last note made by Stoliczka, two days before his death, he records the presence at the Karakoram pass of shales and limestones of Triassic and Liassic age. Thus the material from which the magnificent pinnacles of the western Karakoram, or the precipices of Kinchinjunga, have been carved out is lacking in the eastern extension of the range. Moreover, the absence of a deep gorge in close proximity to the crest of the range, like that of the Indus further west, or of the Tista in Sikkim, lessens the transporting power of the tributary

FIG. 1.—Sources of the River Yarkand. From the *Geographical Journal*, August.

torrents, and causes the hills to become smothered in a mantle of their own débris, so that, as Stoliczka remarks, "it becomes almost an exception to observe a rock *in situ*," and the scenery becomes correspondingly tame.

The occasion of the reading of Dr. de Filippi's paper was memorable in more respects than one. Not only was an opportunity afforded, and happily utilised by the President of the Society, of expressing the cordiality of our relations with Italy, whether we are engaged together in peaceful exploration or in the more serious business of war, but also by the participation in the discussion of the father of Himalayan exploration in that region, Col. Godwin-Austen, and of another pioneer in Central Asian discovery, Sir F. Younghusband.

T. H. D. L.

FIG. 2.—Middle portion of Remo Glacier, Northern Branch. From the *Geographical Journal*, August.

THE EFFECT OF RADIUM ON THE GROWTH OF PLANTS.

AMONG the many remarkable properties of radium it was perhaps natural to expect that it might have some definite effect on plants, and even, under suitable conditions, cause sufficient increase in the amount of growth to justify its use in horticulture and agriculture. The early observations of Dixon and Wigham[1] at Dublin, however, did not seem very promising: 100 seeds of cress (*Lepidium sativum*) were uniformly distributed over an even surface of moist quartz sand, and after germination had taken place a sealed tube containing 5 mgms. of radium bromide was set 1 cm. above the central seed. The seedlings grew up, but without any curvature indicating positive or negative "radiotropism," and the only noticeable effect was a slight depression of growth in those within 1 cm. radius of the tube. As stronger preparations of radium became available more definite retardations and inhibitions were observed: thus Gager, in an elaborate report,[2] noted a more or less complete inhibition in cell activities in younger and especially embryonic tissues, with few exceptions. The action of radium through the soil, however, was different; germination and growth were both accelerated, and the plants furthest away were stimulated most. Acqua[3] found that different plants, and even different organs of the same plant, were differently affected, the root system in general responding more markedly than the aerial parts,

[1] Proc. Roy. Soc. Dublin, 1904, x., 178-192.
[2] Mem. New York Bot. Gard., 1908.
[3] *Ann. Bot.* (Rome), 1910, viii., 223-238.

and in his experiments being arrested in their development.

The intensity of the radiation is important, and G. Fabre,[4] using *Linum catharticum* as test plant, was able to obtain increased development and germination of seedlings by working with emanations up to 1·5 microcuries per 2 litres of air, and to retard development by using emanations of 40 microcuries per litre of air. H. Molisch[5] obtained a like result: young plants of vetches, beans, sunflower, etc., were stimulated in growth by weak emanations, but checked or entirely stopped by stronger ones. He further claimed that the "rest period" could be broken by the radium emanation, and forced lilac into bloom in November by attaching pipettes containing small quantities of radium chloride to the terminal buds.[6] In his earlier experiments he, like Dixon and Wigham, failed to detect any radiotropism, but later on he found indications in the case of certain heliotropically sensitive plants, *e.g.*, oats and vetches.[7]

These and similar results naturally suggested that the residues left after the extraction of radium, but still containing radioactive material, might have definite manurial value, and it was not long before definite statements were forthcoming. Baker[8] claimed that increased yields of wheat and radishes had been obtained by mixing one part of radioactive material (2 mg. ra. per ton) with ten of soil. It is true that Stoklasa's[9] results were negative (although in his other experiments radium emanations increased growth to a marked extent), but this did not prevent the introduction of radioactive fertilisers, and the enterprising syndicates and companies concerned were by no means loth to push their wares. The staffs of the agricultural experiment stations being busy people and, moreover, somewhat sceptical about plant stimulation on account of some rather sad failures, did not generally take the matter up, and it remained for Mr. Martin Sutton to carry out the necessary tests.

Mr. Sutton's experiments were made with radishes, tomatoes, potatoes, onions, carrots, and marrows, some grown in pots, others in plots out of doors. Eight different radium residues were used, in addition to pure radium bromide; the dressings were so arranged that equivalent quantities of radium were given in each case (1/4000 mgm. radium bromide to 15 lbs. of soil in the pots; 2½ times this amount per square yard to the plots). Controls were set up, including a set treated with the other substances present in the residues, designed to ascertain whether those had any effect.

The results have just been issued by Mr. Sutton. Going carefully through them, one is forced to the conclusion that the radioactive materials have been ineffective. In no case is there any clear evidence of increased growth. Even the pure radium bromide seems to have done nothing. We are therefore left with an apparent discrepancy. The work of the physiologists, assuming it to be sound, certainly indicated that radium emanation is capable of stimulating certain cell activities. Mr. Sutton's results show that such stimulus, if it exists at all, does not affect the final growth of the plant. The discrepancy is not a new one, it is periodically confronting the agricultural investigator. Thus Dr. Winifred Brenchley, at Rothamsted, has failed to obtain increases in growth by supplying plants with inorganic poisons which have been supposed to stimulate certain cell functions in suitable dilutions. The result opens up the prospect of an interesting discussion, but it also shows the danger of arguing from a simple physiological observation to a complex phenomenon like the growth of a plant in soil.

E. J. RUSSELL.

4 *Compt. Rend. Soc. Biol.* (Paris), 1911, lxx., 187-183.
5 *Umschau*, 1913, xvii., 95-98.
6 *Oesterr. Gart. Ztg.*, 1912, vii., 197-202.
7 *Sitzber. k. akad. wiss.* (Vienna), 1911, cxx., 305-318.
8 *Journ. Roy. Soc. Arts*, 1913, lxii., 70-78.
9 *Chem. Ztg.*, 1914, xxxviii., 841-844.

PROF. E. A. MINCHIN, F.R.S.

IT is with profound regret that we announce the death, on September 30, at Selsey, of Prof. E. A. Minchin, F.R.S.

Edward Alfred Minchin, younger son of Charles N. Minchin by his wife Mary J. Lugard, was born in 1866. From his birth he suffered from a constitutional weakness, and indeed his life was despaired of at first. He grew stronger with age, yet the premature close of his career was no doubt due to the physical disabilities against which he had so bravely struggled to the very end. Unable to share in the rough life of the ordinary schoolboy, he was educated privately, and then for a short time at the United Service College, Westward Ho! When about fourteen years of age he went to the Bishop Cotton School at Bangalore after having joined his parents in India. Here he lived happy years, free to indulge to his heart's content that love of animals and of natural history of which he had already shown signs in his childhood, sometimes to the consternation of his nurse. He made valuable collections, and developed early his keen powers of observation.

Although Minchin had distinguished himself at school by his aptitude for the classics, it was to natural science that he devoted himself in his university career at Oxford. He obtained an exhibition at Keble College, and took his degree in 1890 with first-class honours in zoology. Shortly afterwards he was awarded the University Scholarship at Naples, and then the Radcliffe Travelling Fellowship. In 1893 he was elected Fellow of Merton College. He was thus enabled to travel abroad to pursue his researches in foreign marine zoological stations, and to work in the laboratories of Prof. Bütschli, in Heidelberg, and Prof. R. Hertwig, in Munich. For several years assistant to Sir Ray Lankester and demonstrator in comparative anatomy at Oxford, he afterwards became lecturer in biology at Guy's Hospital, but soon succeeded Weldon in the Jodrell chair of zoology at University College, London, in 1899.

When, seven years later, a new chair of protozoology was founded in the University of London, Minchin was naturally chosen to fill the post, and undertook the direction of the new department of protozoology at the Lister Institute of Preventive Medicine in Chelsea. Here, to some extent freed from routine work and administrative worries, he pursued his researches with untiring industry, and reached those brilliant results which have made his name famous among protozoologists the world over. In 1910 he was awarded the Trail Medal, and in 1911 was elected a Fellow of the Royal Society. He married Florence Maud Fontain in 1903.

Even as an undergraduate Minchin made his mark as a student of singular ability and originality. His first scientific paper, "On a New Organ in Periplaneta" (*Quart. Journ. Microsc. Science,* vol. xxix., 1888), and a short note on the embryos of Aurelia (*Proc. Zool. Soc.*, 1889), were published before he had taken his degree. Shortly after, he gave the first intelligible account of the working of the extraordinary Cuvierian organs of Holothuria.

But space will allow us here to mention only a few of Prof. Minchin's numerous and valuable contributions to zoological science. He was a specialist in the best sense of the word, deliberately restricting the field of his researches in order to probe the more deeply into the mystery of life. The Porifera and the Protozoa were his favourite groups.

A series of papers, published from 1892 to 1898, on the structure, development, and classification of Calcareous Sponges placed Minchin at once in the first rank of zoological investigators. He was struck with the importance of studying specimens living under natural conditions or preserved in perfectly fresh state. An expert swimmer and diver, he loved to observe his sponges on the rocky coasts of Plymouth, Roscoff, Banyuls, and Naples. He was thus able to solve many of the problems which had baffled the efforts of his predecessors, and to correct not a few of their mistakes. These studies culminated in a masterly and beautifully illustrated memoir on the development of the spicules of the Clathrinidæ (*Quart. Journ. Microsc. Science,* vol. xl.), a triumph of technical skill over the difficulties encountered in dealing with minute histological details. It is typical of all his work: neat and methodical in preparation, accurate and thorough in execution, clear and convincing in presentation. To reach the high standard of accuracy he aimed at, Minchin worked with extraordinary patience and care; no pains were spared, no detail however small was neglected, every refinement of method brought into use. His mastery of technique was indeed remarkable, and great was his ingenuity in devising improvements in the instruments used and routine followed in his investigations.

In later years he devoted more and more of his time to the study of the Protozoa, especially of the parasitic forms. The same skill and care which had yielded such successful results in the study of the Porifera soon won for Minchin a high reputation among protozoologists. In 1905 he spent some time in Uganda on the Royal Society's Sleeping Sickness Commission. From that time his work was confined almost entirely to the elucidation of the life-history of the Trypanosomes. For years he devoted himself to this difficult problem, and the memoir brought out, in conjunction with Mr. J. D. Thomson, last January (*Quart. Journ. Microsc. Science,* vol. lx.), describing in every detail the life-history of *Trypanosoma lewisii* in the rat-flea, will remain a lasting memorial to Minchin's boundless industry and perseverance. Some idea of the magnitude of the work may be gathered from the fact that more than 1600 fleas were dissected and examined in the course of these researches. Among the important discoveries there described may be mentioned the occurrence of an intracellular stage passed through by the Trypanosome in the stomach of its host. Incidentally, Minchin contributed valuable information concerning the life-history and structure of the tsetse-fly and the flea.

It was not, however, by his original researches alone that he advanced zoological science. He wrote many excellent articles in the "Encyclopædia Britannica" and elsewhere, and text-books of the highest merit. The parts he contributed to Lankester's "Treatise on Zoology," dealing with the Porifera and the Sporozoa, are models of clear description and sound judgment based on wide zoological experience and a thorough knowledge of the literature. The later "Introduction to the Study of the Protozoa" is by far the best text-book yet written on the subject in English, or perhaps in any language, and will long remain a standard work.

Minchin had a wholesome horror of hurried or slipshod work, of anything which savoured of sensationalism or self-advertisement. He was always ready to give of his best, whether in his writings or his lectures, whether to his friends or his pupils. As a teacher he was particularly successful at the Lister Institute, where he welcomed and encouraged any who wished to engage in research. There also he lectured and gave practical instruction to students, many of whom were medical men from India and the tropics.

Minchin was a man of cultured intellect and wide interests, with a keen appreciation of the beauties of ancient and modern literature. His published works and his presidential addresses to the Quekett Microscopical Club are distinguished not only for the matter they contain, but also for the admirable form in which it is presented. Nowhere, perhaps, is this better seen than in his last scientific contribution, the presidential address to Section D of the British Association at Manchester. Unfortunately he was prevented from reading it himself by the illness which was so soon to carry him off.

The sudden ending of his scientific career will be deeply felt in the zoological world, not only in England, but also abroad, and especially perhaps in France, where his merits were quickly appreciated. Minchin's great modesty and his

gentle and unassuming character endeared him to his many intimate friends and pupils. His personal charm was greatly enhanced by a keen sense of humour; he delighted in a good story. In conversation Minchin was gifted with a happy turn of phrase. His friend, Mr. Heron-Allen, with whom he spent his last days, tells us that in answer to a quotation from O. W. Holmes, that "Life, as we call it, is nothing but the edge of the boundless ocean of existence where it comes on soundings," Minchin replied, "And death, as we call it, is nothing but the unfathomed deeps of the ocean of existence where we lose the sounding plumb."

DR. T. ALBRECHT.

WE deeply regret to announce the death, on August 31, at seventy-two years of age, of Dr. Theodor Albrecht, departmental chief in the Royal Prussian Geodetic Institute, Potsdam, and chief of the International Bureau for Investigating Latitude Variation since its inception in 1898. By his death, geodesy loses a painstaking and conscientious worker, who laboured zealously to unravel a complicated problem, and to carry forward the investigations so brilliantly inaugurated by the late Dr. Chandler. For many years he occupied himself with the study of the minute changes in the position of the earth's axis, and by his office had been mainly responsible for the methods of observation applied, and the trustworthiness of the results derived.

Prof. Fergola, as is well known, urged the necessity of attacking this question of latitude variation by a uniform and systematic method of observation under international control, so far back as 1883, but it was not until twelve years later that any progress was made, when Profs. Forster and Helmert, supported by the hopeful researches of Chandler, were able to bring the far-reaching scheme to fruition. From that time onward, Albrecht was identified with this plan, to which he gave untiring devotion. Even before his appointment as director, he had signalled his interest in these researches by dicussing the motion of the pole in the interval 1890–95, from observations made at some dozen observatories in Europe and America. Since then Dr. Albrecht issued reports with praiseworthy regularity, and his diagrams showing the excursions of the pole have been models of clearness. Under his superintendence the bureau justified itself by its diligent, patient labour and skill in handling minute details. Criticism has not been wanting, but probably there was little room for originality or brilliancy of treatment.

The late director performed a useful work in keeping an interesting problem before the scientific world, and though in these days there must be great difficulty in maintaining an international bureau, supported by the varying subsidies of many nations, amounting in all, we believe, to about 3000*l*. per annum, it would be a matter of regret if any breach of continuity in the conduct of the bureau should result.

NOTES.

AT the recent meeting in Manchester, the General Committee of the British Association unanimously adopted the following resolution, which has been forwarded to the Prime Minister, the Chancellor of the Exchequer, and the Presidents of the Board of Education and of Agriculture and Fisheries:—"That the British Association for the Advancement of Science, believing that the higher education of the nation is of supreme importance in the present crisis of our history, trusts that his Majesty's Government will, by continuing its financial support, maintain the efficiency of teaching and research in the universities and university colleges of the United Kingdom."

THE urgent need for a wise economy in every department of public and private life is recognised by every patriot anxious to see the war brought to a successful end. A timely protest in the Press from Sir James Yoxall, M.P., against unintelligent and wrongly directed economy deserves notice. At no time in the country's history has it been more necessary that every effort should be made to make our system of education efficient and thorough, so that when military conflict gives place to industrial competition we may be able to hold our own with the central European States. Yet Sir James Yoxall has to direct attention to attempts to save money at the expense of the education of the nation's children. "Supplies of books, stationery, and other needed school appliances are being lessened in amount or reduced in quality; plans are laid for abolishing evening classes and schools; and there is evidence of a wide general slackening in educational provision." Some local education authorities have contemplated reducing the salaries of teachers. "The Amalgamated Association of Operative Cotton Spinners, operatives themselves, and many of them parents, are asking that children may go into the mills to work full time at the age of thirteen. Agricultural people demand 'half-time' for children of eleven; and so does the Cotton Spinners' Trade Union, I understand." Such unwise economy must be discouraged everywhere, and it is the duty of every influential person to do his part to prevent any deterioration in the work of our schools and colleges, because upon it our country's welfare ultimately depends.

MR. E. W. SWANTON has been elected president of the British Mycological Society.

THE Thomas Hawksley Lecture of the Institution of Mechanical Engineers will be delivered on Friday, October 29, by Dr. Dugald Clerk; the subject will be, "The World's Sources of Fuel and Motive Power."

A PRELIMINARY meeting to discuss the formation of a proposed Society for the Study of Geological Physics will be held at the rooms of the Geological Society of London, Burlington House, W., on Thursday, October 14, at 3.30 p.m. The chair will be taken by Prof. Benjamin Moore.

THE issue of *Science* for September 17 announces the death of Prof. Karl E. Guthe, professor of physics in the University of Michigan and dean of the

Graduate School; and of Prof. J. H. Van Amringe, dean of Columbia College, and professor of mathematics until his retirement five years ago after a service of fifty years.

THE Rome correspondent of the *Morning Post* states that in consequence of comments on his Germanophil attitude, the Marquis Cappelli has resigned the presidency of the Royal Geographical Society of Italy, and the resignation has been accepted. As the Marquis Cappelli is also president of the International Agricultural Institute, the question is being asked whether he will now retain that position.

THE director of the Meteorological Office reports that information has been received from the seismological observatory at Eskdalemuir, Langholm, Scotland, of the record of a large earthquake which occurred at 7 a.m. G.M.T. on Sunday, October 3. The computed position of the epicentre is between Colorado, U.S.A., and the Island of Guadelupe, off the coast of California.

WE learn from the *Pioneer Mail* that the programme of the Board of Scientific Advice for India during the year 1915–16 includes the following work of the various scientific departments:—The meteorological department will continue observational work with pilot balloons at various stations, and will also do some experimental work on vertical air currents at Agra. In the astronomical department a new spectroheliograph is under construction, which it is hoped will be completed during the year. Five Omori seismographs, two at Simla, two at Calcutta, and one at Bombay, the Milne seismograph at Kodaikanal, and several instruments of local manufacture at Bombay, will be kept in use during the year for scientific research work. Geological surveys will be continued in Bombay, Central India, Rajputana, the Central Provinces, Burma, and Kashmir. In connection with the botanical survey of the country, the curator of the herbarium and the systematic assistants will work up, with a view to publication, the material of the past year's exploration in Southern India, and the material presented by contributors not belonging to the department for field work. It is proposed to continue the exploration of Travancore by the curator of the herbarium and an officer of the department. This field work will be of practical use in connection with the flora of Madras now under preparation. In the industrial section of the Indian Museum plant breeding and plant improvement work will be continued on wheat, tobacco, gram, fibre plants, indigo and oilseeds; and fruit entomology will include general investigations of crop pests, and especially of the pests of rice, sugar-cane and cotton, fruit trees, and stored grain. Under the head of agriculture, the following are among the lines of work in progress:—The combination of irrigation and drainage in the growing of rice; the study of the inheritance of the more important characters of dairy cattle by crossing; the building up of milk pedigree in cattle by selection.

THE Rev. Cyrus Byington, born in 1793, served for fifty years as a missionary among the Choctaw Indians, and died full of years and honour in 1868. He translated into Choctaw several books of the Old and New Testaments, and compiled a grammar of the language. His chief work was a Choctaw-English Dictionary, which he left in manuscript without final revision. This has now been done by Mr. J. R. Swanton with the assistance of Mr. H. S. Halbert, who spent many years among the Choctaws, became familiar with their language, and is an enthusiastic student of everything relating to the past history and present culture of the tribe. The dictionary, which has now been published as Bulletin 46 of the Bureau of American Ethnology, will be welcomed by all students of the languages of the American Indian tribes.

IN *Man* for October, Mr. T. E. Peet discusses the types of megalithic monuments found in the peninsula of Sinai, which are interesting in connection with the question of rude stone monuments in the Mediterranean basin, and also in view of a possible relation between their builders and the early Egyptians. The monuments consist of beehive tombs, rock circles, and hut circles. Much further investigation is needful before their origin and relations can be fixed with certainty. Mr. Peet, who writes with commendable caution, thinks that the evidence does not satisfactorily prove their connection with Egypt. As regards the Mediterranean relations, he remarks that the more specialised features of the true megalithic system—dolmens, the use of really large stones, and the combination of large orthostatic slabs and corbelled courses of masonry, as found in Malta and Sardinia —do not exist. Possibly further investigation may provide examples of these features, but at present we lack evidence to connect Sinai with the Mediterranean megalithic area.

IN the Journal of the College of Agriculture of the Imperial University, Sapporo, Japan (vol. vi., pt. vii.), Mr. J. Yamare discusses the inheritance of "notched" ears in Ayrshire cattle. This marked abnormality recognised in American herds of the breed is due to a Mendelian dominant factor, but it is of interest to find that heterozygote individuals show the "notching" only in a greatly reduced condition.

STUDENTS of the Dragonflies will welcome Mr. Clarence H. Kennedy's "Notes on the Life-history and Ecology of the Odonata of Washington and Oregon" (Proc. U.S. Nat. Mus., vol. xlix, pp. 259–345). The habits of the insects when pairing and egg-laying are described, and structural details of the nymphs and of the imagos at different ages are made clear by means of an excellent set of illustrations.

DR. A. E. CAMERON has spent a year in New Jersey as a research fellow of the Victoria University, Manchester, and gives some of the results of his studies in an article on potato spraying and dusting, published in the Bulletin of Entomological Research (vol. vi., part i.). It is established that Bordeaux mixture with arsenate, in addition to its effect as a fungicide, kills the beetle-enemies of the potato crop. Dr. Cameron directs especial attention to the profitable

co-operation found in the United States between scientific experts, farmers, and chemical manufacturers, and wishes that similar conditions might be brought about in this country.

THE trustees of the British Museum have issued an account of the Nemertine Worms collected on the *Terra Nova* Antarctic Expedition (Nat. Hist. Report, Zoology, vol. ii., No. 5), by Mr. H. A. Baylis. The number of species is small, and most of them are represented by few examples, but the author in his systematic and anatomical descriptions and drawings has made the most of the material at his disposal. Worms from Antarctic localities described by other naturalists as species of Cerebratulus and Eupolia, are all referred to M'Intosh's Kerguelen species *Lineus corrugatus*, which, on this view, has an extensive circumpolar range.

A VALUABLE account of the penguins of South Georgia, by Mr. R. C. Murphy, has been published, in the form of a bulletin (vol. ii., No. 2) by the Brooklyn Institute of Arts and Sciences. The charge of wanton slaughter, which the author makes against the crew of the *Daisy*, a sealing brig which he accompanied for the purpose of studying the penguin rookeries, makes painful reading. It would seem that the doom of the king penguin, so far as South Georgia is concerned, is sealed. In addition to his studies of this bird, Mr. Murphy gives some lengthy notes on the Gentoo penguin (*Pygoscelis papua*). Since so much has already been written on these birds, more than Mr. Murphy seems to be aware of, judging from his references to the literature of this subject, it is not surprising to find that the author has nothing new of importance to record. In one particular he has missed a fine opportunity. We have heard much of the central "pouch" and of the "flap of skin" under which the king penguin incubates its egg, and later broods its young, but so far no really careful, or accurate, description of this structure has yet been given. Mr. Murphy has done nothing to help forward the solution of this matter.

THE Geological Survey of Great Britain describes the mainland portions of Sheets 330 and 331 in a memoir by H. J. O. White on "The Geology of the Country near Lymington and Portsmouth" (1915, price 1*s*. 6*d*.). The district includes the admirably fossiliferous strata of Bracklesham and the Oligocene beds of Brockenhurst, where a band occurs in the Headon series that is more purely marine than its representative in the Isle of Wight. It is stated that the drowned valley of the Solent and the inlets near Portsmouth generally have been considerably enlarged by marine erosion.

THE United States National Museum has received from a marine Miocene formation in California the greater part of the skull of the rare Sirenian Desmostylus, which shows that in several respects this is one of the most primitive genera of its order. The snout is not bent downwards so much as in modern sirenians, and the nostrils are comparatively small and far forwards. The new specimen is described in detail by Dr. O. P. Hay in the Proceedings of the United States National Museum, No. 2113, and reference is also made to an allied species found on the opposite coast of the Pacific in Japan.

THE difficulty of restoring extinct reptiles, even when nearly complete skeletons are known, is well illustrated by the armoured dinosaur Stegosaurus, described by Mr. C. W. Gilmore in a recent part of the Proceedings of the United States National Museum (No. 2110). When Marsh first found the greater part of a skeleton of this reptile, he supposed that its large plates of bony armour were arranged as a ridge along the middle of the back; subsequent authors recognised that the plates were not median, and regarded them as forming a paired series; Mr. Gilmore now concludes that the plates were neither median nor paired, but must have formed two alternating series along the middle of the back. He also thinks that the largest plates were above the root of the tail, not above the pelvis, and thus he feels obliged to make the trunk shorter than in previous restorations. A readjustment of the head gives to Stegosaurus the appearance of a browsing animal.

THE *American Journal of Science* for September, 1915 (vol. xl., No. 237), contains two papers of special geological interest. W. M. Davis gives the results of his studies, during 1914, of the coral-reefs of the Pacific, and strongly supports the theory put forward by C. Darwin "when he was twenty-five years old and before he had ever seen a true coral-reef." W. H. Twenhofel discusses the making of black shale, such as that in which graptolites abound. He shows, from a remarkable instance on the Esthonian coast, described by several Russian writers, that black slimes are not necessarily deposits of deep water, but may fill up coastal shallows. The blackness is in this case due to hydrocarbons of vegetable origin; the absence of tides, and a cool temperate climate are favouring conditions. "Sulphur gas" is present, and the author believes that animal remains would ultimately be pyritised in such an environment. Anærobic bacteria probably play a large part in the production of the slime. The muds of the Black Sea are contrasted with these shore-deposits.

THE August number of *The Royal Engineers' Journal* (vol. xxii., No. 2) contains a lengthy summary of General Maitrot's study of the strategical relations of France and Germany. The original appeared in French in a third edition this year as "Nos Frontières de l'Est et du Nord," and while in the main it deals with military considerations, contains a valuable study of the geography of the western theatre of war. Major W. A. J. O'Meara's summary is accompanied by several useful maps from the original publication. Events have proved the accuracy of General Maitrot's estimate of the value of the geographical factor in the plan of campaign.

INVESTIGATIONS of ocean currents around Australia have been made by floats thrown overboard from various vessels. A chart indicating the drift of fifty of those which have been recovered from the end of 1909 to the middle of 1914 has been published by the Commonwealth Government. Most noticeable is the

E.N.E. course of those set adrift in the forties in contrast to the general E.S.E. track of those from the thirties south of Australia. As most of the floats were cast up on relatively unfrequented shores where they may have lain a considerable time before discovery, it is impossible to form any estimate of their rate of travel. Nor can any conclusions be drawn from the absence of floats on a coast, as, for example, the western coast of the south island of New Zealand, where none have been found; this may be due to that coast being less frequented than the western coast of the north island, where many were picked up.

THE rainfall in Australia in 1914 is shown in a series of charts prepared by Mr. H. A. Hunt, and issued by the Commonwealth Government. The year was noticeable for its drought, and in South Australia, the Riverina, western Victoria, and much of Tasmania it was the driest year on record. These conditions resulted in a failure of the crops over the greater part of the wheat belt, with a production only some 30 per cent. of the previous season. Tasmania suffered least of all parts of the wheat belt, but in other parts of southern Australia the deficiency of rain in the cool part of the year averaged from 25 per cent. to 72 per cent. These conditions were related to anti-cyclones of great intensity, which kept south of their normal track across Australia, and moved very slowly, with the result that the "Antarctic" disturbances failed to reach Australia to any great extent. The weakness and failure of the winter rains were partly counterbalanced in the warmer months by unusually strong monsoons. In western Australia, Victoria, central and southern New South Wales in November and December, these rains were far above the average. On the whole, the drought of 1914 was not so widespread as the droughts of 1888 and 1902, but was locally more intense. Queensland and tropical Australia largely escaped.

IN the *Tôhoku Mathematical Journal* (viii., 1) Mr. Kihizi Yanagihara, in a note entitled "A Theorem on Surface," offers a proof of the statement that if one surface always cuts a second surface in a plane curve or several simply closed plane curves, then the first surface must be a sphere.

IN a paper on "General Expression for Stress Components" (Proceedings of the Tokyo Mathematical Physical Society, viii., 2 (1915)), Mr. Senien Yokota considers the problem of an infinite plate containing a circular hole in which a plug can be inserted, or having complete or partial contact with its periphery. The plate is supposed to be under a uniform tension in a fixed direction. It would appear that whether the plug is loose or just fits the hole, the maximum tangential tension on the periphery of the hole is three times the tension applied to the plate. This result is no doubt of interest in connection with the problem of rivets.

IT is remarkable that while aeroplanes the engines of which have been disabled by shrapnel can pursue their erratic paths to earth without any prospect of having their equations of motion solved, mathematicians are still covering pages of formulæ with attempts to solve the problem of three (hypothetical) bodies. We have before us a paper by Prof. T. Levi Civita on "The Reduction of the Problem of Three Bodies" (Venice: Carlo Ferrari, 1915; reprinted from the *Atti del R. Istituto Veneto*, lxxiv., 2, pp. 907–939), and Mr. D. Buchanan discusses a new isosceles solution in the Transactions of the American Mathematical Society, xvi., 3, pp. 259–274. We can only hope that these and other writers on this problem will speedily bring their investigations to such a state of perfection as to render it impossible to discover anything further on the subject. When this is done, they will find aeroplanes clamouring for a little attention.

IN response to numerous requests for information as to the melting points of the chemical elements, the Bureau of Standards at Washington has issued a table of melting points according to the most trustworthy data. The following are the melting points on the thermodynamic scale used by the bureau as standard temperatures in the standardisation of thermometers and pyrometers: Mercury $-38.9°$, tin $231.9°$, cadmium $320.9°$, lead $327.4°$, zinc $419.4°$, antimony $630.0°$, aluminium $658.7°$, silver 960.5, gold $1063.0°$, copper $1083.0°$, nickel $1452°$, iron $1530°$, palladium $1549°$, platinum $1755°$, tungsten $3000°$. At temperatures of $1000°$ the uncertainty is of the order $0.1°$, at platinum $5°$, and at tungsten $100°$ C. A further table of other standard temperatures is given in which the following are included: normal boiling point of oxygen $-183.0°$, sublimation of carbon dioxide in an inert liquid $-78.5°$, normal boiling points of water $100°$, naphthalene $217.96°$, benzophenone $305.9°$, sulphur $444.6°$, freezing point of sodium chloride $801°$ C.

THERE is an interesting description with photographs in *Engineering* for October 1 of what is in many respects the most remarkable old steam engine in existence. This is a Newcomen engine used at the Farme Colliery, Rutherglen, near Glasgow. The valve gear is of the simplest possible kind, and is worked by hand, just as was the case with the original Newcomen engine. The engine is used for winding, and draws a cage up in 35 seconds, making 16 revolutions while doing so. The cylinder has a diameter of 2 ft. 8¼ in., and the stroke is 5 ft. 6 in. The mean pressure is 7·35 lb. per sq. in., and the boiler pressure is 3 lb. per sq. in. The maximum indicated horse-power is 27.

IN addition to the works referred to in the last two numbers of NATURE, the following forthcoming books of science are announced:—In *Agriculture*—The Spirit of the Soil: An Authorised Exposition of the Theories and Results evolving from Prof. Bottomley's Inoculation of Soil by Means of Bacteria, G. D. Knox, illustrated (Constable and Co., Ltd.); Poultry Husbandry, E. Brown, illustrated (E. Arnold). In *Anthropology and Archaeology*—Savage Man of Central Africa, Dr. A. L. Cureau (T. Fisher Unwin, Ltd.). In *Biology*—The Hill Birds of Scotland, S. Gordon, illustrated; Thirty-five Years in the New Forest, Hon. G. Lascelles, illustrated (E. Arnold); Trout Fly-Fishing in

America, C. Z. Southard, illustrated; The Rambles of a Canadian Naturalist, S. T. Wood, illustrated (J. M. Dent and Sons, Ltd.); Bramble-Bees, J. H. Fabre (Hodder and Stoughton); Bird Behaviour, F. Finn; Insect Artisans and their Work, E. Step (Hutchinson and Co.); The Book of the Wilderness and Jungle, F. G. Aflalo; Wild Animals of Yesterday and To-Day, F. Finn; The Common Beetles of our Countryside, W. E. Sharp (S. W. Partridge and Co.); Wonders of Animal Life, W. S. Berridge (Simpkin and Co., Ltd.). In *Geography and Travel*—By Forest Ways in New Zealand, F. A. Roberts, illustrated (Heath, Cranton and Co., Ltd.); Java: Past and Present, D. Campbell, 2 vols., illustrated (Heinemann); How to Read Ordnance Maps, J. F. Unstead; Philip's Human Geographies, H. Fairgrieve and E. Young (G. Philip and Son, Ltd.); With Scott: the Silver Lining, T. G. Taylor, illustrated (Smith, Elder and Co.). In *Geology*—Earth-Lays: Geological and other Moods, C. Tolly (J. M. Dent and Sons, Ltd.). In *Mathematical and Physical Science*—Text-Book of Navigation and Nautical Astronomy, Capt. A. P. W. Williamson, new edition, illustrated (John Hogg). In *Medical Science*—Mosquito Control in Panama: the Eradication of Malaria and Yellow Fever in Cuba and Panama, J. A. Le Prince and A. J. Orenstein (G. P. Putnam's Sons). In *Technology*—Handbook of Technical Instruction for Wireless Telegraphists, J. C. Hawkhead and H. M. Dowsett, new edition, illustrated (The Wireless Press, Ltd.). In *Miscellaneous*—The Limitations of Science, Prof. L. T. More (Constable and Co., Ltd.); Social Progress and the Darwinian Theory, G. W. Nasmyth; Darwin and the Humanities, Prof. J. Mark Baldwin (G. P. Putnam's Sons).

OUR ASTRONOMICAL COLUMN.

MEASURES OF JUPITER.—Numerous visual and photographic measures of the diameter of this planet have been made by the Rev. Father S. Chevalier, S.J., of the Zô-Sé Observatory, during 1912–13 (*Mem. Soc. Spett. Ital.*, July, 1915). The Gautier micrometer used in the visual work provides for the measures being made by bringing two strips of platinum tangential to the limbs of the planet, either (i) internally, *i.e.* with both strips seen in front of the disc, or (ii) externally, both strips beyond the disc. The two sets of measures thus obtained were of closely similar accuracy. In the photographic work very many separate exposures were made on each plate, affording material for a considerable body of measures. The exposures were graded in seven groups according to intensity, and measures on only four of these sets were used in taking the means. The discarded groups were those in which the images were considered either too small through under-exposure or enlarged by irradiation. The mean results may be summarised as follows:—

	Polar diam.	Equat. diam.
Visual measures ...	35·37″	38·16″
Photographic measures	35·20″	37·99″

The value of the aplatissement derived from both sets is practically identical, its reciprocal being 13·6, indicating a decidedly greater flattening than hitherto ascribed to this planet. Thus in one of the most important memoirs recently published (Lau, *Ast. Nach.*, No. 4673) the diameters are given as 35·4″ and 37·6″, yielding 17 as the reciprocal of the ellipticity.

THE ROTATION PERIOD OF CERTAIN JOVIAN MARKINGS.—Jupiter is now well situated for observation, and Mr. W. F. Denning, in the Journal of the Royal Astronomical Society of Canada (September), indicates some directions in which useful work may be done. The subject of the paper is the rotation period of the great red spot and of the hollow in the southern equatorial belt. The yearly values of the rotation period are tabulated for the eighty-four years, 1831–1914 (inclusive). Waiving the debatable point involved in the formation of this sequence, the period has varied between 9h. 55m. 33·3s. (1831) and 9h. 55m. 41·7s. (1898). Special attention is directed to the very marked acceleration since 1910. The mean period of rotation for about 74,170 rotations comes out at 9h. 55m. 36·9s. After such a weighty determination one hesitates to mention a value based on twenty-nine rotations, but M. Chevalier's recent photographic measures are worthy of note (*Mem. Spett. Ital.*, vol. iv., September 2, p. 113). The point measured was the western extremity of the south tropical disturbance, and the period deduced 9h. 55m. 10·4s. ± 0·7s., a faster movement than Mr. Denning assigns to the dusky south tropical disturbance (9h. 55m. 20s. approx.). The question of co-ordinating the visual and photographic observations would no doubt in happier times have led to extensive polemics.

R. CORONÆ BOREALIS.—This irregular variable has been manifesting light-changes during the past summer (see this column, August 19). We now learn from the Monthly Register of the Society of Practical Astronomy that in Bulletin No. 585 Harvard College Observatory, August 14, 1915, Prof. E. C. Pickering states that attention had been directed to its diminution in brightness by Mr. Eaton, and Mr. Bancroft found its magnitude 6·8 on July 24 and 6·9 on the 25th; whilst at Harvard, on August 13, its magnitude was only 7·7 (Mr. Campbell).

A 10-INCH DIFFRACTION GRATING.—A short paper by Prof. A. A. Michelson on the ruling and performance of a giant diffraction grating (*Proc. Amer. Phil. Soc.*, No. 217, p. 137) affords most inspiring reading. Rowland's gratings accomplished so much, yet the interferometer, the echelon, and the plane parallel plate brought such undreamed-of resolving powers into practical employ that it might well have been imagined that the grating had had its day. Michelson, the pioneer of the newer methods, realised early their disadvantages, and twelve years ago set about constructing a perfect screw 20 ins. in length, with the hope of some day ruling a grating 14 ins. long. Mechanicians will delight in the ingenious devices which have brought realisation within reach, and even encourage the undertaking of a 20-in. grating. Thus for correcting the screw an interferometer method was adapted enabling measurement to within 1×10^{-6} of an inch. An auto-collimating method of straightening the guiding ways ensured rectilinear motions within one second of arc. The grating carriage was nearly floated in mercury. Longitudinal movement of the screw was geometrically eliminated by allowing its spherically rounded end to bear against an optically plane surface of diamond fitted with adjustments to secure normality to the axis of the screw. Periodic errors could be corrected by using a worm-wheel to rotate the screw, and those of higher order were eliminated by a mysterious "correcting device." So long ago as 1910 a 6½-in. grating had been produced and was employed by Messrs. Gale and Lemon in a research demanding resolving powers rivalling those of interference spectroscopes; now a ruled surface 9⅜ in. × 2⅞ in., having 11,700 lines per inch, has been achieved and tested in a spectrograph of the Littrow form with an 8-in. 20-ft. Brashear lens. The

theoretical resolving power in the sixth order is 660,000, and 600,000 has actually been attained on a negative from which was prepared the illustration accompanying the paper.

THE SOLAR PHYSICS OBSERVATORY, CAMBRIDGE.—We have received a copy of the second annual report of the director relating to the year April 1, 1914, to March 31, 1915. Disadvantageous conditions arising out of the war have imposed serious limitations on the output of work, and have also retarded the installation of equipment. Mr. Baxandall has made considerable progress in working out the details of the chemistry stellar spectra for the projected atlas. The green regions of the spectra of α Cygni, α Canis Minoris, α Persei, and α Canis Majoris have been reduced, and the results are being prepared for publication. Spectra of several bright stars have been photographed in the course of adjusting the new spectrograph used with the 15-in. Huggin's refractor. Solar work has evidently been prosecuted both with zeal and success. The observers with the South Kensington spectroheliograph are especially to be congratulated on having secured spectroheliograms of the sun's limb on no fewer than 110 days. The solar eclipse expedition to Theodosia in the Crimea was very unfortunately foiled by clouds, and this is doubly regrettable as the eclipse provided some novel spectroscopic features. Successful photographs of sun-spot spectra have been secured with the McClean solar instruments. In the laboratory a powerful spectrograph of the Littrow type has been improvised, using a 6-in. plane grating and a 6-in. Cooke photovisual lens, and thus the 21-ft. concave grating detained at Odessa will scarcely be missed.

LONG-DISTANCE WIRELESS TELEPHONY.

THE announcement that the United States Navy Department has successfully experimented with a wireless telephone from Arlington, Virginia, to Mare Island, California, is chiefly interesting on account of the distance covered—2500 miles. If this success can be maintained in all conditions it will mark a notable achievement and one upon which the naval authorities in the United States may be complimented, because of the many years of steady and silent work which they have devoted to the subject.

There is nothing inherently impossible in long-distance wireless telephony, and from the scientific point of view there is no reason why it should not be carried on over even greater distances than that recorded above, but there are practical difficulties in regard to the construction of a microphone transmitter capable of passing large high-frequency currents, and in the production of the necessary persistent oscillations. In ordinary telephony, the current going through the microphone is quite small, and so long as the power to be dealt with is small, it is easily possible to obtain a microphone capable of dealing with the amount of energy while giving good articulation. But when a power measured in kilowatts has to be dealt with it is another matter. By using many microphones in parallel; by cooling the carbon granules with gas or immersing them in oil, and a host of similar devices, inventors have sought to produce one capable of dealing for protracted periods with a heavy current; but either they have not been entirely successful in this, or articulation has suffered. It is therefore desirable to await a full official account of the experiments carried out by the United States Navy Department before expressing an opinion upon the results. This is all the more necessary because of the great difficulty of judging the success of long-distance and other experiments merely by "reading."

It is extraordinary, in practice, to observe the marked difference between the distance at which speech is audible and the distance to which it is truly intelligible. The faint overtones and small nuances upon which intelligible speech depends are, at best, all too lightly impressed on the ever-varying curve of intensity sent out; and if they are smothered up or glossed over by a coarse microphone, a distant receiving station where the signals are weak gets only the bare fundamental tones stripped of all meaning. It is very easy to be deceived in this, and when well-known words are uttered, the ear glibly supplies the missing sounds.

EXPERIMENTS ON HOMING.[1]

PROF. J. B. WATSON and Dr. K. S. Lashley have made some important experiments at Bird Key, in the Tortugas, on the homing capacity of the noddy tern (*Anous stolidus*) and the sooty tern (*Sterna fuliginosa*), which breed there in large numbers. The island is peculiarly suitable for the purpose, since it marks the northern limit of the migration of these two tropical terns (so that if the birds are experimentally transported further north they find themselves in regions which they have not previously visited); moreover, on the westward side there is only the open water of the Gulf of Mexico until the shore-line of Texas is reached, Galveston being 855 statute miles distant. "This strip of open water proves a magnificent route for homing experiments." The authors caught terns at their nesting-places, put individual marks of paint on their head and neck, tied a small tag recording the date, locality, and marking round the neck, fixed a larger duplicate tag beside the nest, transported the birds in large cages to a distance, liberated them, and watched for their return. The general result is of great interest:—"The noddy and sooty terns can return from distances up to 1000 miles in the absence of all landmarks, at least so far as the term landmark is understood at present."

Some details of this careful piece of work may be noted, for they are very instructive. From Galveston (855 miles away) three birds returned out of ten, taking from about six to about twelve days; two noddies liberated at 720 miles both returned, taking between eleven and seventeen days; out of ten birds liberated at 585 miles eight returned, taking from about four to about eight days; out of four noddies and four sooties liberated in open water 461 statute miles away, two noddies returned in three days; of twelve taken north to Mobile, only one returned, taking about seven days; two noddies and two sooties carried in a state-room to Havana and released in the harbour there early in the morning of July 11, returned to Bird Key on the 12th, the distance in a straight line being about 108 statute miles; of three noddies and two sooties liberated off Cape Hatteras (850 miles to the north), both of the latter and at least one of the former species returned after several days. "The alongshore route, which is the one in all probability chosen by the birds on their return, since they were gone several nights, is approximately 1081 statute miles." (It seems that the birds almost never rest on the water, unless they happen to find pieces of driftwood or the like.) The records show that the terns often take as long for short distances as for long distances, and that a return from the open sea outside of all landmarks is just as practicable as a return from a coast.

By a series of exceedingly careful experiments Dr.

[1] Papers from the Department of Marine Biology of the Carnegie Institution at Washington. Vol. vii., "Homing and Related Activities of Birds." By J. B. Watson and K. S. Lashley. Pp. 1–104+7 plates+9 figs. (Washington: The Carnegie Institution, 1915.)

Lashley has shown that the problems of proximate orientation are relatively simple and straightforward. On the island of Bird Key the terns make their adjustment to the nest, mate, young, etc., on a basis largely of visual habits. Kinæsthetic habits are also involved, but to a less extent. On dark nights the sooty tern hovers over the crowded nesting area, giving out his call; he is answered by his mate and young, and is thus guided to the nest. Dr. Lashley found no evidence of any remarkable or unusual sensitiveness, or of the functioning of any hypothetical sense-organ.

As to the more difficult problem of distant orientation, the authors consider and dismiss various suggestions: that the birds follow water-currents; that they get their bearings by ascending to a great height; that they have special visual acuteness, *e.g.* to infra-luminous rays; or that they have special tactual or olfactory sensitiveness in the nasal cavities. The experimental thoroughness with which the spectral sensitivity and the functioning of the nasal chamber are dealt with is worthy of imitation. The authors are unwilling to suggest at present the assumption of any new and mysterious sense; they rightly prefer to continue to experiment. They suggest various experiments, *e.g.* on the sensory equipment of homing pigeons, and they conclude:—"We are far from being without hope that future studies may yield results which will enable us to solve the riddle which has been propounded to scientific men of all ages, but as yet never satisfactorily answered."

THE INSTITUTE OF METALS.

At the meeting of the Institute of Metals held in London on September 17, a number of interesting papers were read and discussed. Amongst these were the following:—"Specifications for Alloys for High-speed Superheated Steam Turbine Blading," by W. B. Parker. In this paper the author confines his attention to a consideration of the non-ferrous alloys which are used for turbine blading. He gives a clear description of the physical and chemical properties which are essential for this purpose, and discusses in detail the causes of the wearing and corrosion of the blades. It is pointed out that although non-ferrous alloys have the advantage of being non-rusting, they do not possess a good proportional limit which is capable of being retained for long periods when exposed at the temperature of highly superheated steam. This fact has so far prevented the use of non-ferrous alloys for this particular purpose, and steel alloys are invariably utilised. The proportional limit should remain, for temperatures between 100° and 450° C., within 10 per cent. of its value at the ordinary temperature. Investigation is, therefore, needed, in order to find either (1) a non-ferrous alloy which will almost indefinitely retain its hardness up to a temperature of 450° C., or (2) a steel which will fulfil the above requirements and also be non-rusting. Anyone conducting research along these lines will find Mr. Parker's paper extremely valuable.

"The Constitution of Brasses Containing Small Percentages of Tin," by Dr. Hudson and R. M. Jones. This paper deals with the constitution of the ternary alloys containing from 50 to 70 per cent. of copper and 0·5 per cent. of tin. The ranges in which the various constituents can exist, at temperatures below the lowest thermal critical points of the alloys, have been determined, and the results are embodied in a constitution diagram. Most of the alloys fall into one of the two following groups: (1) Those in which the tin is held in solid solution, and consequently possess the normal structure of the copper-zinc series, and (2) those in which a constituent is present, which is similar to the δ of the copper-tin alloys.

"A Thermostat for Moderate and High Temperatures." The authors of this paper, J. L. Haughton and D. Hanson, describe a simple and much-needed apparatus which they have designed for keeping constant temperatures for long periods. The records illustrated in the paper show that the apparatus is highly satisfactory. By using fused silica in the place of glass it is hoped that the effective range of temperature will be considerably extended.

"Metallic Crystal Twinning by Direct Mechanical Strain." In this paper Prof. C. A. Edwards gives evidence which proves that certain metallic crystals are twinned when subjected to mechanical deformation without the intermediate operation of annealing. In the case of tin the twinning is very marked, even at the temperature of liquid air. Diagrams are shown to illustrate the possible mechanism of twinning, and from a consideration of these it is concluded that amorphous layers are produced on the twinning planes.

"The Micro-chemistry of Corrosion," by Dr. Desch and H. Hyman. The corrosion of gun-metals has been examined by the electrolytic method. The presence of tin decreases the rate of corrosion by forming a layer of basic salts which act as a protective coating on the metallic surface. Coarsening the structure by annealing increases the corrosion. A pure alpha alloy is more readily acted upon than one which contains the eutectoid, but the presence of the beta, obtained by quenching, has very little effect.

ON THE FUNCTIONS OF THE CEREBRUM.[1]

The first of these papers is a study of thirty-eight cases of insanity (dementia præcox, general paralysis, arteriosclerotic dementia, and senile dementia) and their autopsies. It is pointed out that entirely different symptoms (hallucinations, delusions, loss of memory, disordered conduct) may occur in different patients, although the associated cortical atrophy may occur in precisely the same areas; also that the same symptoms may occur in different patients in whom the cortical atrophy is subsequently found to be in different areas. The author, however, ignores the fact that different *layers* of the cerebral cortex are affected in the different diseases.

The second paper is the result of an experimental study of cerebral localisation in monkeys. It is there pointed out that any given cortical motor centre (the leg area, for example) differs in size and shape in different animals of the same species, in the two hemispheres of the same animal, and even in the same hemisphere at different times. For instance, it is found that the arm can sometimes be stimulated from a spot in the middle of the leg area, sometimes not. From these data Dr. Franz draws conclusions as to certain possible connections between neurons. We are quite prepared to go even as far as this with him; but when he offers these neural arrangements as an explanation of "the variations of behaviour of different animals and of the same animal at different times to the same form of stimulation," we must join issue. Not so much that Dr. Franz's suggestions are incorrect from a neurological point of view

[1] (1) "Symptomatological Differences Associated with Similar Cerebral Lesions in the Insane." (2) "Variations in Distribution of the Motor Centres." By Shepherd Ivory Franz. (Princeton, N.J.: *Psychological Review* Co.)

as that they are insufficient to satisfy the requirements of psychology.

Both these papers are too materialistic, and take no notice of modern psychological research, which has demonstrated the paramount importance of *experience* in determining modes of reaction. This is especially remarkable in a publication issued in a series of "Psychological Monographs" by the "*Psychological Review* Company," of Princeton, N.J.

GEOLOGY AT THE BRITISH ASSOCIATION.

THE address of the President, Prof. Grenville A. J. Cole, was a brilliant and stimulating commencement to the proceedings of this section. Following it came an interesting address by Dr. George Hickling on the geology of Manchester and district, in which he pointed out the excellent position of Manchester, both geographically and geologically, situated at the junction of the red beds and the coal measures, with a great variety of opportunities for field-work in the neighbouring Pennine Chain. Prof. E. J. Garwood followed with a paper on the discovery of Solenopora and Sphærocodium in the Silurian rocks of Britain. Up to the delivery of his presidential address at Birmingham these organisms had not been found in Silurian rocks, but careful search has now proved that Solenopora occurs both in the Wenlock and Woolhope limestones. In areas on the borders of Herefordshire and Radnorshire had been found crystalline limestones, upwards of 80 ft. thick, containing remarkable developments of these and similar algal growths, amongst which were the remains of Girvanella and Sphærocodium, the latter genus being now recorded for the first time from rocks in Britain.

Prof. W. Boyd Dawkins contributed two papers. The first was on the classification of the Tertiary strata by means of the Eutherian mammals, based on their evolution. The most important break in the succession of life-forms occurs at the close of the Oligocene period, since when there is a marked continuity showing that the present face of the earth is merely the last in a long succession in the Tertiary period. His second paper dealt with the geological evidence in Britain as to the antiquity of man. He agreed with Prof. Boule in regarding the evidence of the rostrocarinate eoliths found in East Anglia as of doubtful value. The Ipswich skeleton was obtained from a shallow pit of decalcified boulder clay (not boulder clay *in situ*) into Glacial sands, and was, he believed, a case of interment which might be of any age from neolithic to modern times. In the case of the Piltdown skull, he fully accepted Dr. Smith Woodward's opinion that the find belongs to the early Pleistocene period. The evidence indicated that man appeared in Britain and the Continent at the period when he might be expected to appear from the study of Tertiary mammalia—at the beginning of the Pleistocene age, when the existing Eutherian mammalian species were abundant. He may be looked for in the Pliocene, but in the older strata he can only be represented by an ancestry of intermediate forms.

On September 9 a joint discussion was held with Section E on the classification of land forms, which will be reported in the records of that Section. Afterwards Canon Bonney gave some notes on new sections in Charnwood Forest. Considerable quarrying had thrown light on sections previously described, which had caused him to modify his previous views. He was now convinced that the dominant Bardon breccia was really a very exceptional case of fluxion breccia. Prof. W. W. Watts followed with notes on the granite surfaces of Mount Sorrel. It had been suggested that some of the ground and polished surfaces known in this area and in certain other Midland localities might be due to wind action in Pleistocene times. A recently discovered section at Mount Sorrel showed glacial striæ crossing wind grooves at a high angle, proving that the Triassic wind grooves had survived actual glaciation.

Dr. A. H. Cox and Mr. A. K. Wells contributed an account of investigations on the Ordovician sequence in Cader Idris. Re-examination of the area had shown that the older views of the igneous rocks of this area, as all of Arenig age, must be modified. Four distinct volcanic centres in the Ordovician series had now been discovered. Prof. W. G. Fearnsides presented a preliminary account of investigations to prove the underground contours of the Barnsley seam of coal. The sites were plotted on a half-inch map, the depths to the coal were corrected for height above sea-level, and contour lines had been drawn among the spot-levels so obtained. From an analysis of the underground contours of the Barnsley bed, it is found that its strike lines generally range from N.E.–S.W. or N.W.–S.E., it being difficult to find either a N.–S. or E.–W. strike constant over more than a few miles of country. The greatest structural division of the coalfield basin is by the equivalent of a N.E.–S.W. anticline, of which the southern limb is along the line of the Don faults from Sheffield to Doncaster. North of this line there is some evidence of a syncline with its axis central near Frickley. The inclination of the Barnsley bed is steepest near the outcrop, the measures flattening out when the central line of the syncline is approached. The map indicates the interdependence of underground structure and topographical relief.

On September 10 both morning and afternoon meetings of the Section were required to complete the programme. The morning session commenced by a description by Prof. J. W. Sollas of reconstructions of fossils by serial sections, illustrated by several remarkable models of restorations of a graptolite, a primitive fish, the skull of a reptile from the Karoo, and the skull of *Ichthyosaurus communis*, from Lyme Regis. The last-named was 520 mm. in length, and had been studied in 520 sections taken at equal intervals apart, and revealed in remarkable detail the internal structure of the head. Prof. R. C. Wallace, of Manitoba, described the brine springs of that area, which issue from the Middle and Upper Devonian limestones, and circulate in the Dakota limestone at the base of the Cretaceous, depositing salt at certain dolomitic horizons. The salt flats where the springs reached the surface were devoid of vegetation and studded with ice-carried boulders, granite, gneiss, etc., which have suffered intense chemical disintegration. Ferromagnesian minerals have been most intensely affected. The causes of this special disintegration, as compared with that of sea-water, were discussed. The boulders were partially submerged and films of liquid were maintained on the surface, in contact with atmospheric oxygen. Owing to partial adsorption by colloids an acid residual solution was produced, which is a powerful corrosive agent.

Dr. Albert Wilmore dealt with the Carboniferous limestone zones of N.E. Lancashire, describing the sequence found in the neighbourhood of Clitheroe and the Knoll district. Mr. H. Day referred to observations on a collection of fossils from Treak Cliff and Peakshill, Castleton, and discussed the value of the brachiopods and corals as zonal determinations, when compared with those of the Bristol area. He concluded that any system of zonal indices could be of local value only, and not of general application. Dr. Arthur Vaughan, who was recovering from a serious

illness, dealt with the shift of the western shore-line in England and Wales during the Avonian period. He concluded that a land mass stretching from Wales to Wicklow formed a barrier during the Avonian period between a "N.W. channel," reaching to the Isle of Man and the Lake district, and a "S.W. channel," which was an extended Bristol Channel. This barrier formed the land-crest between these two channels during the whole of Viséan time, and had a dominant trend from Anglesey to Dudley. The whole neck of land which contained the barrier and separated the "channels" shifted steadily southwards as Viséan time proceeded, owing to the advance of the sea on its northern side and its retreat on the south. The remarkable similarity of the Viséan sequence north and south of this barrier indicated free sea communication round its western margin, along which the sea remained persistenly coastal during the period.

Dr. Albert Jowett contributed a preliminary note on the glaciation of the western slopes of the southern Pennines. No striated surfaces of solid rock had been found at high levels, and for detailed information of the ice-movement we had to depend on striations at Salford and Fallowfield, on the distribution of drift at high levels, and on the systems of drainage along the edge of the ice. These indicated a general movement from N.W.–S.E. The first barrier of hills met with on approaching the Pennines from the South Lancashire and Cheshire plain was almost everywhere overridden with ice, which left definite deposits of drift with foreign rocks up to 1360 ft., and scattered erratics up to 1400 ft. This drift had been traced across the main Pennine divide near Chapel-le-Frith (1100 ft.). Great lakes were held up by the ice-barrier some time after it commenced to retreat from the western slope of the Pennines. During early stages of the retreat the drainage from the lakes in and north of the Etherow valley escaped northwards, and ultimately discharged through the Walsden gap into the Calder. When the ice-barrier east of Manchester fell below 600 ft., this drainage followed the course of that south of the Etherow valley and escaped southwards.

The afternoon meeting commenced with a discussion on radio-active problems in geology. Sir E. Rutherford opened the discussion by putting the problem from the point of view of the older geologists, with their comparatively low estimate of the age of the earth, though higher than physicists of those days were inclined to concede. The discovery of radium had greatly modified the position, and the age of the earth, based on evidence of radio-activity, was very much higher than the estimates accepted by geologists. The problem was how to reconcile geological facts with these new physical determinations. Sir Ernest Rutherford was inclined to believe that the larger estimates were nearer correct than the smaller.

Prof. J. Joly faced the problem from the viewpoint of the geologist on the assumption that geologists were agreed on the matter. He made several suggestions which might have the effect of reducing the large numbers derived from the study of radio-active materials.

Prof. Soddy hoped that geologists would not be in any immediate hurry to decide between the geological and radio-active estimates of the age of the earth. Owing to the element of uncertainty about the initial stages of the disintegration and the long periods involved, there was a great *terra incognita*, and the new theory of isotopes made it necessary to take into account many possibilities not thought of a couple of years ago. In addition there was always the possibility that thorium might be a branch of the uranium family, in which case some of the arguments that had been used entirely fell to the ground. While he saw no successful method at present of altering the *general* order of the radio-active estimate, he did not regard it as more than tentative, and there might well be unknown factors of sufficient importance to bring the two methods into closer agreement in the future. Dr. J. H. Teall, Prof. Sollas, and Dr. J. W. Evans continued the discussion.

Prof. C. A. Edwards described the results of experiments producing twinning in metallic crystals. His remarks were illustrated by an interesting series of lantern slides. Dr. J. W. Evans followed with a description of the different methods by which the interference figures of a small mineral in a rock slice could be kept distinct from those of the adjoining minerals. He discussed various methods of using a diaphragm with the Becke combination of lenses, and condemned the common practice of placing the diaphragm for this purpose immediately below the Bertrand lens.

Dr. G. Hickling contributed a paper on the microstructure of coal, illustrated by a series of beautiful lantern slides, showing remarkable success in dealing with very difficult material. He concluded that coal was essentially a "replacement" deposit consisting of an original peat-like mass of vegetable *débris*, in which the substance of the component tissues has been largely or wholly replaced by the liquid decomposition products of other vegetation. The concluding paper was by Mr. Thomas Crook, describing the economic mineral products of Damaraland, S.W. Africa, and emphasising their value. Several research committees were reappointed; and new committees were appointed to investigate rocks of Old Red Sandstone age at Rhynie, Aberdeenshire, and of Lower Carboniferous age at Gullane, Haddingtonshire. The sectional work concluded with a field excursion to Edale and Castleton. The surprise of the week was the magnificent weather, which made a successful meeting also a delightful memory.

W. L. C.

CORRESPONDING SOCIETIES AT THE BRITISH ASSOCIATION.

THE first meeting of the Conference of Delegates was held on September 8, and it was announced that the General Committee of the British Association had altered the titles of officers of the Conference from Chairman and Vice-Chairman to President and Vice-President, thereby giving them the same status as those of the Sections. Sir Thomas Holland delivered his opening address, entitled "The Classification of Scientific Societies," which was printed in NATURE of September 16.

The first subject for discussion was "Local Museums," suggested by the Selborne Society, and introduced by Dr. W. E. Hoyle. He laid it down that the first and fundamental function of a museum was to preserve. Museum officials are nowadays given so much advice about the desirability of making our exhibits æsthetically attractive, of compiling explanatory labels which shall at the same time instruct the specialist and interest the casual visitor, and of catering for school children, that they are, he said, in danger, perhaps, of forgetting that their paramount duty is to see that "neither moth nor rust doth corrupt" and that "thieves do not break through nor steal."

He gave a definition of a local museum, the first duty of which, he maintained, was to preserve the things of interest pertaining to the locality. Then he touched upon the important and delicate question of

the relations which ought to exist between the local museum and the national museum. Difficulties arose when it was required to determine in particular cases what objects were of national importance and should be preserved in a national museum.

After the first function of a local museum had been adequately discharged, Dr. Hoyle thought that if means and opportunities allowed, collections should be provided which gave the visitor a preliminary sketch of some department of knowledge. He alluded to "index" collections, though he thought the term "introductory" collections would be more appropriate. Dr. Hoyle had something to say with regard to the coming into touch of the museum with the educational system of the locality, and he saw nothing out of place in a local museum developing a special subject quite disconnected with the locality if it had the power to do so without interfering with its proper work.

In the discussion which followed, Dr. Bather touched upon principles which should guide local curators in their selection of what should be considered of national and local interest. Type specimens should be placed in museums where they would be well looked after. Moreover, researchers, though they would naturally seek for local objects, such as fossils, in a local museum, ought not to have to look for, say, New Zealand fossils, through all the museums of the British Isles.

Dr. Marie C. Stopes thought that there might be a balance of good in decentralising collections, even of type specimens, for the visiting of local museums brings a stimulus to the local people, and widens and humanises the interests of specialists.

It seemed evident from other remarks that if local museums are to be properly educational, in the general sense of the word, there should be special institutions or special sections of existing museums with their own organisation, so as not to burden curators unduly.

Prof. Geddes directed attention to the survey of Greater London now being carried out by the Architects' War Committee, which deserved the co-operation of museums and natural history societies.

The second meeting was held on Friday, September 10. As a result of the importance of the presidential address, and the interest which had been taken in its suggestions, the vice-president, Mr. William Whitaker, moved a resolution in the following terms:—"That this conference invites the attention of the Corresponding Societies' Committee to the president's opening address, in which suggestions are made for reforming the existing, varied, and unorganised practice of publishing original papers." An outline was given of ways in which this might be done, and the resolution was carried.

The second subject for discussion was "Colour Standards," suggested by the British Mycological Society, and introduced by Mr. J. Ramsbottom. He described and illustrated a number of the schemes which had been formulated with the object of obtaining some uniformity of colour description in the many branches of natural science. Recent attempts at colour standards have each something against their general adoption, and, except for horticulturists, mycologists, and possibly ornithologists, they are much too full. It would seem best to have a well-arranged list of two hundred well-named colours for ordinary use, which colour scheme could be amplified in those branches of science where needed.

In this case, also, a good discussion was aroused, and as it was pointed out that the work of preparing such a series of colour standards for scientific and commercial uses, though of interest to many of the committees of the Association, was not the province of any one of them, a resolution was passed referring the matter to the Corresponding Societies' Committee.

In many ways the Conference of Delegates at Manchester was the most successful that had been held in this country for a considerable time.

Wilfred Mark Webb.

SECTION B.

CHEMISTRY.

Opening Address [1] by Prof. William A. Bone, D.Sc., F.R.S., President of the Section.

This year is, as many of you are doubtless aware, the centenary of Davy's invention of the miner's safety lamp which formed the starting point of his brilliant researches upon flame, in which he disclosed, and brought within the range of experimental inquiry, most of the intricate and baffling problems connected with the fascinating subject of gaseous combustion. Also the ground on which we meet to-day is known to the whole scientific world as the place where, during more than a quarter of a century of continuous investigation, a succession of Manchester chemists, led and inspired by Prof. H. B. Dixon, have devoted themselves to the elucidation of the many problems which Davy's work foreshadowed. Therefore, both in point of time and place, the occasion is singularly appropriate for a review of recent advances in this important field of scientific inquiry.

At the Sheffield meeting of the Association in 1910, I had the honour of presenting to a joint conference of Sections A and B (Physics and Chemistry) a report summarising the then "State of Science in Gaseous Combustion," [2] which gave rise to a keen and stimulating discussion, and was not only printed *in extenso* in the annual reports for that year, but was also widely circulated through the medium of the scientific and technical Press. There is no need, therefore, for me to refer in any detail to the results of researches already dealt with in that report. I can more usefully devote part of the time at my disposal to supplementing it with a review of more recent researches, which have considerably extended our knowledge in many directions.

Gaseous Combustion: Ignition Phenomena.

The first section of my 1910 report was concerned with ignition temperatures and the initial phases of gaseous explosions; and it is in connection with ignition phenomena that subsequent progress has been most marked.

For the ignition of a given explosive mixture, it is necessary that the temperature of its constituents should be raised, at least locally, to a degree at which a mass of gas self-heats itself by combination until it bursts into flame, or, in other words, to a degree at which the chemical action becomes autogenous or self-propelling, so that it quickly spreads throughout the whole mass. This particular degree, or in some cases range, of temperature is commonly spoken of as the ignition-point of the mixture; but in using the expression, certain qualifications should be carefully borne in mind. In the first place, as H. B. Dixon and H. F. Coward showed in 1909,[3] whereas when certain combustible gases—such, for example, as hydrogen and carbon monoxide, the mechanism of the combustion of which is probably of a fairly simple character—and air or oxygen are separately heated in a suitable enclosure before being allowed to mix, the temperature at which ignition occurs lies within a

[1] Abridged by the author.
[2] See *Journal of Gas Lighting*, vol. cxi., p. 648.
[3] *Ibid.*, vol. cvii., p. 323.

very narrow range, which is, within the limits of experimental error, the same for both air and oxygen (*i.e.* in the case of hydrogen it is 580° to 590°, and for carbon monoxide 640° to 658°). On the other hand, in cases where the mechanism of combustion is known to be very complex (*i.e.* hydrocarbons), the ignition range is either fairly wide or else is materially lower in oxygen than in air (or both). Thus—

	In air	In oxygen
Methane	650°–750° ...	556°–700°

The explanation of such behaviour is probably to be sought in the known complexity of the combustion, and the marked tendency for appreciable and fairly rapid interaction between the inflammable gas and oxygen before the actual ignition-point is reached. If, by any means, such preliminary interaction could either be entirely suppressed, or if, on the other hand, it be very rapid in character, the observed "ignition range" would be narrowed, as is actually the case with ethylene (542° to 547° in air, and 500° to 519° in oxygen).

There are two other means by which an explosive mixture may be ignited. One is by adiabatic compression, and the other, and most commonly employed of all, is by the passage of an electric spark. The adiabatic compression of an explosive mixture was originally suggested by Nernst as a means of determining its ignition-point, provided (1) that ignition is not produced locally, while the main temperature of the gas is still far below the true ignition temperature; (2) that the piston of the apparatus does not move appreciably after the gas has been raised to its ignition-point. At the time of my 1910 report, Falk, in America, had applied the method in the case of hydrogen and oxygen mixtures, with results which, in the light of more recent work, would appear to have been misleading or erroneously interpreted. Thus, for instance, he found that of all the mixtures of hydrogen and oxygen, the equimolecular H_2+O_2 mixture has the lowest ignition temperature (514°), from which he concluded that the gases react initially to produce hydrogen peroxide rather than steam. Such a conclusion, which I believe to be erroneous, naturally directed attention to the experimental method involved.

The subject was promptly taken up here, in Manchester, by H. B. Dixon and his co-workers,[4] with the result that much new light has been thrown on the phenomena accompanying ignition. The ratio of the ignition temperature to the initial temperature of the mixture before compression, both expressed in degrees absolute (T_2/T_1), may be calculated from the compression ratio (V_1/V_2) by means of the well-known formula for adiabatic compression:

$$\frac{T_2}{T_1}=\left(\frac{V_1}{V_2}\right)^{\gamma-1}$$

where γ = the ratio of the specific heats at constant pressure and volume, respectively, of the mixture compressed, and which for a mixture of diatomic gases, such as hydrogen and oxygen, is usually taken as 1·40.

Dixon's recent photographic analysis of the appearance of flame when mixtures of carbon bisulphide and oxygen (CS_2+3O_2) are adiabetically compressed, have proved that the flame, starting from a point or layer, always takes an appreciable time to spread through the mixture, and that unless special precautions are taken to arrest the piston at the moment of its attainment of the ignition condition, it may be driven in much further than the minimum distance for ignition.

The real ignition-point, as above defined, is not necessarily synchronous with the actual appearance of the flame. There may be, and usually is, an appreciable "pre-flame" period. Only in the fastest burning mixtures is this period negligible; hence the necessity of artificially stopping the movement of the piston at the beginning of the period—a precaution which Falk seems to have neglected.

According to Dixon and Croft's recent determination by this method of the ignition-points of mixtures containing electrolytic gas, whereas successive additions of hydrogen or nitrogen progressively raise the ignition temperature of the undiluted gas by regular increments, as would be supposed, successive additions of oxygen, on the other hand, lower it, as a glance at the following table will show:—

Ignition Points of Mixtures Containing Electrolytic Gas by Adiabatic Compression.

(H. B. Dixon and J. M. Crofts, 1914.)

Electrolytic Gas, $2H_2+O_2=526°$

$+x\,H_2$	$+x\,N_2$	$+x\,O_2$
x=1 ... 554°	x=1 ... 537°	x= 1 ... 511°
x=2 ... 561°	x=2 ... 549°	x= 7 ... 478°
x=4 ... 602°	x=4 ... 571°	x=15 ... 472°
x=8 ... 676°	x=8 ... 615°	
(526+18 x)°	(526+11 x)°	

The observed raising effects of successive dilutions with hydrogen and nitrogen call for no comment, save that the relatively greater effect of hydrogen as compared with nitrogen may be attributed to its greater thermal conductivity; but the lowering effect of oxygen is indeed puzzling, and its meaning can only be conjectured. Dixon and Crofts have suggested that it may be due either to the formation of some active polymeride of oxygen under the experimental conditions, which seems to me doubtful, or that the concentration of oxygen in some way or other brings about increased ionisation of the combustible gas. This at once raises the larger question of whether or not ignition is a purely thermal problem, as until recently has generally been supposed.

Prof. W. M. Thornton, of Newcastle-upon-Tyne, recently published some very suggestive work on the "Electrical Ignition of Gaseous mixtures,"[5] which, apart from its theoretical interest, has an important bearing on the safety of coal mines where electrical currents are used for signalling and other purposes.

The common belief that any visible spark will ignite a given explosive mixture of gas and air is, of course, quite erroneous; for just as Coward and his coworkers have shown that for a given explosive mixture and sparking arrangement there is a certain limiting pressure of the gaseous mixture below which ignition will not take place, so from Thornton's work it would appear that a definite minimum of circuit energy is required before a given mixture at given pressure can be ignited by a spark. And, moreover, he has stated that the circuit energy required for the spark ignition of a given mixture (say) of methane and air is something like fifty-six times greater with alternating than with continuous current at the same voltage. From this he has argued that the igniting effect cannot be simply thermal, but must be in part at least ionic. This conclusion he further supports with the statement that the igniting power of a unidirectional current is proportional to the current in the case of many gaseous mixtures over an important part of their working range of inflammability.

While there is much that is suggestive in Thornton's work, there is also a good deal which seems

[4] H. B. Dixon, L. Bradshaw, and C. Campbell, Trans. Chem. Soc., 1914, pp. 105, 2027; H. B. Dixon and J. M. Crofts, *ibid.*, p. 2036.

[5] Proc. Roy. Soc., A, vol. xc., 1914, p. 272; vol. xci., 1914, p. 17.

very difficult to interpret from a chemical viewpoint. I here refer more particularly to his later supposition of "stepped ignition," which is based upon certain observed abrupt increases in the minimum igniting current required with condenser discharge sparks as the proportion of combustible gas in the air mixture examined progressively increases. In other words, it is claimed that continuous alteration of the proportions of gas and air in an explosive mixture is, or may be, accompanied by discontinuous alterations in the spark energy required for ignition. I must confess that, after careful examination of the published curves, I am quite at a loss to give them any chemical interpretation, and to being somewhat sceptical about the supposed "stepped ignition." A repetition and extension of Prof. Thornton's experiments would be most valuable as a means to a better understanding of the conditions of spark ignition.

Influence of Electrons upon Combustion.

During the discussion upon my 1910 report, Sir J. J. Thomson reminded us chemists that combustion is concerned, not only with atoms and molecules, but also with electrons moving with very high velocities. They might be a fact of prime importance in such intensive forms of gaseous combustion as are realised in contact with hot or incandescent surfaces, as also in the explosion wave. It is well known, of course, that incandescent surfaces emit enormous streams of electrons travelling with high velocities, and the actions of such surfaces may be due to the formation of layers of electrified gas in which chemical changes proceed with extraordinarily high velocities. Again, the rapidity of combustion in the explosion wave might, he thought, conceivably be due to the molecules in the act of combining sending out electrons with exceedingly high velocities, which precede the explosion wave and prepare the way for it by ionising the gas.

With regard to this interpretation of the action of surfaces, Mr. Harold Hartley carried out a promising series of experiments in my laboratory at Leeds University upon the combination of hydrogen and oxygen in contact with a gold surface, which lend some support to the idea. But they require further extension before it can be considered as finally proved. It is my intention in the near future to resume the systematic investigation of the matter as rapidly as circumstances permit; but the experimental difficulties are formidable, and the mere chemist working by himself may easily be misled. We badly need the active co-operation of physicists in elucidating the supposed *rôle* of electrons in combustion.

Prof. H. B. Dixon and his pupils have, at Sir J. J. Thomson's suggestion, recently tested the idea as applied to the explosion wave, with, however, negative results.[6] It is known, of course, that the motion of the ions can be stopped at once by means of a transverse magnetic field, in which they curl up, and are caused to revolve in small circles; and the question which Prof. Dixon decided to put to the test of experiment was whether the damping of the electronic velocities in a powerful magnetic field would have any appreciable effect either upon the initial phase of an explosion or upon the high velocity of detonation. But though he employed a very intense magnetic field produced by some powerful magnets specially constructed by Sir Ernest Rutherford for the deflection of electrons of high velocity, no appreciable effect was observed upon the character or velocity of the flame with any gas mixture at any stage of the explosion. And inasmuch as the high constant velocity of the explosion wave can be entirely accounted for on the theory of a compression wave liberating the chemical energy as it passes through the gases, there seem as yet to be no experimental grounds for attributing it to the ionising action of electrons.

[6] Proc. Roy. Soc., 1914, Section A, vol. xc., p. 506.

The Initial Period of "Uniform Movement" or "Inflammation" of Flame through Inflammable Mixtures, and Limits of Inflammability.

Mallard and Le Chatelier, in their classical researches upon the combustion of explosive mixtures, discovered that the propagation of flame, when such a mixture is ignited in a horizontal tube, differs according as whether the ignition occurs near the open or closed end of the tube. In the first case, the flame proceeded for some distance down the tube at a practically uniform and fairly slow velocity, corresponding to the true rate of propagation "by conduction." This period of uniform movement is succeeded by an irregular oscillatory period, in which the flame swings backwards and forwards with increasing amplitudes, finally either dying out altogether or else giving rise to detonation. With certain oxygen mixtures, the initial period of uniform slow velocity was shorter, and appeared to be abruptly succeeded by detonation without the intervention of any oscillatory period. When, however, such mixtures were ignited near the closed end of a horizontal tube, the forward movement of the flame was continuously accelerated from the beginning, under the influence of reflected compression waves, until detonation was set up. Such, in general, was the sequence of the phenomena that were observed by these distinguished French investigators.

They proceeded to determine experimentally the velocities of the uniform slow movement of the flame in the case of a number of air and combustible gas mixtures, and plotting their results (in cms. per sec.) as ordinates against percentages of inflammable gas as abscissæ, they obtained "curves" which were in each case formed of two inclined straight lines converging upwards to a point which represented the composition and flame velocity of the most explosive mixture. And they concluded that the points at which the downward production of the two lines met the zero velocity line would define the upper and lower limits of inflammability for the particular series of gas-air mixtures. Thus the curve they obtain for methane-air mixtures showed a maximum velocity of 61 cms. per second for a mixture containing about 12·2 per cent. of methane, with lower and upper limits corresponding to 5·6 and 16·7 per cent. of methane respectively.

An exact knowledge of the velocities of flame propagation during this initial period of uniform slow movement, as well as of the limits of inflammability for mixtures of various combustible gases and air, is very important from a practical point of view. Makers of apparatus for burning explosive mixtures of gas and air want to know the speed of flame propagation through such mixtures, not only at ordinary temperatures and pressures, but also when the mixtures are heated and used at higher pressures. Also, it would be important to know whether or not, in the case of a complex mixture of various combustible gases and air, when complete composition can be determined by analysis (as, for example, coal gas and air), the velocity of flame propagation can be calculated from the known velocities for its single components. Unfortunately, although more than thirty years have elapsed since Mallard and Le Chatelier's work was published, the necessary data are still wanting to answer such questions; and anyone who will systematically tackle the problem and carefully work

it out in detail will be doing a real service to the gas-using industry.

An accurate knowledge of the behaviour of methane-air mixtures under known variations of conditions is of prime importance from the point of view of the safety of coal mines, and it is rightly occupying the attention of my friend and former collaborator, Dr. R. V. Wheeler, at the Home Office Experimental Station at Eskmeals. From papers which he has already published, as well as from some unpublished results which he has very kindly permitted me to refer to in this address, it is now possible to correct certain errors in Mallard and Le Chatelier's results, and to arrive at a clear view of the phenomena as a whole.

In the first place, it would appear that the initial "uniform movement" of flame in a gaseous explosion, or, in other words, propagation of the flame from layer to layer by conduction only (as defined by Le Chatelier) is a limited phenomenon, and is only obtained in tubes of somewhat small diameter—wide enough, however, to prevent appreciable cooling of the flame, but narrow enough to suppress the influence of convection currents. Moreover, ignition must be either at or within one or two centimetres of the end of the tube; otherwise—particularly with the more rapidly moving flames—vibrations may be set up right from the beginning.

While all methane-air mixtures develop an initial uniform slow flame-movement period when ignited at, or near, the open end of a horizontal tube, both its linear duration as well as the flame velocity are not, according to private information which Dr. Wheeler has sent me, independent of the dimensions of the tube. The speed of flame increases with the diameter of the tube; and the linear duration of the uniform period increases with both the diameter and length of the tube up to a certain maximum, after which increased length probably makes no appreciable difference. Also, for the same tube, it varies with the proportion of methane in the explosive mixture—being greater as the speed of the flame diminishes, until with the two "limiting" explosive mixtures it appears to last almost indefinitely.

Dr. Wheeler's recent re-determination of the velocities of the flame movement during this initial uniform period for mixtures of methane and air in varying proportions within the limits of inflammability, has revealed serious errors in Mallard and Le Chatelier's original results for horizontal tubes of the same diameter as those which Dr. Wheeler has employed. Moreover, Mallard and Le Chatelier's method of determining the composition of the upper and lower limits of inflammability by extrapolation from their curves has been proved to be unwarranted. Dr. Wheeler considers the length of the tubes used by Mallard and Le Chatelier (1 metre only) was insufficient to ensure that the speed measurements of the initial uniform flame-movement period were unaffected by the subsequent "vibratory period." Also, the methane used by them, prepared as it was from sodium acetate, would obviously be impure. According to Wheeler, the limits of inflammability for horizontal propagation of flame in methane-air mixtures, at atmospheric temperature and pressure, correspond to 5·4 and 14·3 per cent. methane contents, respectively.

Messrs. Burgess and Wheeler have recently determined the limits of inflammability of methane when mixed, at atmospheric temperature and pressure, with "atmospheres" of oxygen and nitrogen containing less oxygen than ordinary air. From their results (see below) it would appear that, as the oxygen content of the atmosphere is reduced, the limits of inflammability are narrowed until they coincide when the oxygen content falls below 13·3 per cent., which means that an atmosphere containing 13·3 or less per cent. of oxygen is truly extinctive for a methane flame at ordinary pressures.

Atmosphere		Methane, per cent.	
Oxygen	Nitrogen	Lower limit	Higher limit
20·90	79·10	5·60	14·82
17·00	83·00	5·80	10·55
15·82	84·18	5·83	8·96
14·86	85·14	6·15	8·36
13·90	86·10	6·35	7·26
13·45	86·55	6·50	6·70

Behaviour of Weak Mixtures of Gases and Air.

My review of this part of the subject would be incomplete without a reference to some interesting observations which have been made by Dr. H. F. Coward and co-workers at the Manchester School of Technology, upon the behaviour of weak mixtures of various inflammable gases and air, at, or just below, the lower limit of inflammability in each case.[7] Their principal experiments were carried out in a rectangular box of 30 cm. square section and 1·8 metres length, with two opposite sides of wood, and the other two of plate glass. The box was placed in an upright position, the bottom being water-sealed and the top closed, with a suitable igniting device placed near the bottom. They have shown that caps or vortex rings of flame may be projected for some distance upwards from the source of ignition—sometimes apparently for an indefinite distance—without igniting the whole of the combustible mixture. In such mixtures there may be an indefinite upward slow propagation of flame, together with incompleteness of combustion, much of the combustible mixture remaining unburnt, and the question very naturally arises as to how the term "inflammability" should be scientifically defined. Dr. Coward has argued, with some force, that a gaseous mixture should not be termed "inflammable" at a given temperature and pressure, unless it will propagate flame indefinitely—the unburnt portion being maintained at that temperature and pressure. Inflammability thus defined would be a function of the temperature, pressure, and composition of a particular mixture only, and would be independent of the shape and size of the containing vessel; and, provided that it is kept in mind that for each particular mixture at a given temperature and pressure a certain minimum igniting energy and intensity is requisite, I am inclined to agree with the definiton. Also, there is a possibility that in a mixture just at, or very near, one or other of the limits of inflammability, flame may be propagated upwards, but not downwards.

From his experiments, Dr. Coward has assigned the following as the lower limits of inflammability of hydrogen, methane, and carbon monoxide respectively, in air at atmospheric temperature and pressure:—

	Per cent.
Hydrogen	4·1
Methane	5·3[8]
Carbon monoxide	12·6

Recent Investigation upon the Combustion of Hydrocarbons and the Relative Affinities of Methane, Hydrogen, and Carbon Monoxide respectively for Oxygen in Flames.

(This part of the address, which was read as a separate paper, reviewed the principal results of an investigation by Prof. Bone and collaborators on

7 Trans. Chem. Soc., 1914, vol. cv., p. 1859.

8 Too much stress need not be laid upon the difference between this number and the 5·6 per cent. given by Dr. Wheeler (*loc. cit.*) because Dr. Coward himself admits that the flames of mixtures containing from 5·3 to 5·6 per cent. of methane are very sensitive to shock; while a 5·6 per cent. mixture will always propagate flame indefinitely, even when there is a moderate disturbance. The conditions must be exceedingly tranquil to prevent extinction in the other cases.

"Gaseous Combustion at High Pressures," recently published *in extenso* in Phil. Trans. Roy. Soc., A, vol. ccxv. (1915), pp. 275 to 318.)

Fuel Economy and the Proper Utilisation of Coal.

Leaving now the scientific aspects of flame and combustion, I wish to say a few words as a technologist upon the great national importance of a more adequate scientific control of fuel consumption and the utilisation of coal generally, with special reference to the situation created by this terrible and ruinous European conflict. And my remarks will be addressed in part to my chemical friends and colleagues, who are primarily interested in scientific research and its industrial applications, and in part also to the commercial and manufacturing community which is chiefly interested in the financial results of such scientific activity.

Notwithstanding the fact that we are raising annually in the United Kingdom—according to the official estimate for 1913—287 million tons of coal, of which 189 million tons (or, say, 4 tons per head of the population) were consumed at home, more or less wastefully, it is indeed surprising how little has been done, or is being done, by the scientific community to impress upon the Government and the public generally the importance of establishing some systematic control or investigation of fuel consumptions in all large industrial areas. Deputations have waited upon the Government about the question of reviving our languishing coal-tar colour industry; so that in future we may be independent of Germany for the supply of the 2,000,000*l*. of dye-stuffs required by our textile industries; and already a State-aided organisation, with an advisory scientific committee, has sprung into existence to achieve this desirable result. But no organised body of men of science, so far as I know, has ever thought it important, or worth while, to take an active interest in the vastly greater subject of fuel economy and the proper utilisation of coal, upon which the dyeing industry depends for its raw material.

It is unnecessary for me to remind you that the contending armies in this Armageddon of the nations depend upon certain distillation products of coal for their supplies of high explosives; and there is little doubt in my mind but that Germany's violation of the neutrality of Belgium, and her subsequent seizure of that country and of a large tract of northern France, had more than a purely political or strategic significance. She, doubtless, wanted also to seize for herself (and at the same time to deprive her enemies of) coalfields lying just beyond her own borders, which are capable of furnishing abundant supplies of coal admirably adapted for yielding the raw materials for the manufacture of high explosives. A country in which all metallurgical coke has for years past been manufactured under chemical supervision in bye-product coking-ovens, with recovery of ammonia, tar, and benzol, and in which the wasteful beehive coking-ovens have long ago ceased to exist, was scarcely likely to overlook the military importance of the Belgian coalfield with its many bye-product coking-plants. And, moreover, but for German commercial acumen and enterprise, during many years past, our own bye-product industry would not have attained even to its present respectable dimensions. Certainly it owes very little to the interest or attention of British chemists, most of whom are, unfortunately, but little aware of its circumstances and conditions, and seem to care even less for its particular problems. And yet, in proportion to the capital outlaid upon it, it is one of the most profitable of all our chemical industries, coal-tar colours not excepted.

Fuel economy, and the proper utilisation of coal, whether in connection with manufacturing operations or domestic heating, will become one of the most important national questions during the trying years that will follow hard upon this war, because of all directions in which national economy can be most healthfully and advantageously exercised, this is perhaps the most obvious and prolific. For it is tolerably certain that, with an efficient and systematic public supervision of fuel consumption, we ought to be able, even with existing appliances, to save many millions of pounds of our annual coal bill, and with improved appliances still more millions—a saving which would in the long run redeem a considerable amount of the war loan which has been much more easily raised than it will be repaid.

Now, I fear that not only are chemists for the most part lamentably ignorant of the nature of coal, and of modern fuel technology, but they have been for many years past so indifferent about such questions that they have been content to leave them almost entirely to engineers, who, as a body, are notoriously deficient in chemical sense and experience. The engineer has, indeed, not usurped the place of the chemist, but has had to do his best to fill the position long since abdicated by the chemist.

This, indeed, seems strange when we remember that the foundations of modern chemistry were deeply laid by investigators who were, above all things, "fire-worshippers." But, judging from most chemical text-books, nearly all that the modern student of chemistry is taught in our academies about combustion was known to Lavoisier; and I question whether in the majority of our university laboratories any investigation on coal or combustion is ever undertaken. And yet the subject is full of most fascinating and fundamental theoretical problems—for the most part unsolved—and the nation consumes every week as much coal as could be exchanged for the whole quantity of aniline dyes used by its textile industries in a year.

Moreover, such advances as have been made during recent years—and they are by no means inconsiderable—have nearly all been in the direction of the wider applications of gaseous fuels. Yet in how many of our university laboratories is even gas analysis taught, or how many of our schools of chemistry provide systematic courses in the chemistry and manipulation of gases, without which no professional training of industrial chemists, however much "research work" it may include, ought to be considered satisfactory? It is my opinion that this important branch of our chemical craft and science has not, for many years past, been accorded its proper place and share of attention in the ordinary curriculum of the majority of our academic institutions.

Of the 189 million tons of coal consumed in the United Kingdom in the year 1913, about 40 million tons, or, say, approximately one-fifth of the whole, were carbonised either in gas works, primarily for the manufacture of towns' gas, or in coke-ovens for the manufacture of metallurgical coke—in practically equal proportions. Two-thirds of the latter was carbonised in bye-product recovery plants; the remainder in the old wasteful beehive ovens. So that, roughly speaking, we have—

Total coal carbonised=40 million tons				
In gas-works		In bye-product coke ovens		In beehive coke ovens
20	...	13·5	...	6·5

At present there are 8297 bye-product coke-ovens built in this country, of which 6678 are fitted with benzol recovery arrangements, capable of producing something like 10 million tons of coke per annum.

The yields of the various bye-products obtainable on such coke-oven installations naturally vary with the locality and character of the coal seam; but they probably average somewhat as follows—expressed as percentages on dry coal carbonised:—

District	Ammonium sulphate	Tar.	Benzol and toluol as finished products
Durham ...	0·9 to 1·45	2·5 to 4·5	0·6 to 1·0
Yorkshire ...	1·3 to 1·5	3·5 to 5·0	0·9 to 1·1
Derbyshire ...	1·3 to 1·6	3·5 to 5·0	0·9 to 1·1
Scotland ...	1·4 to 1·6	3·5 to 5·0	0·9 to 1·1
South Wales ...	0·9 to 1·1	2·0 to 3·5	0·6 to 0·75

Or, to put the matter a little differently, each ton of dry coal carbonised yields from 20 to 35 lb. of ammonium sulphate, from 56 to 112 lb. of tar, and from 2 to 3½ gallons of crude benzol, etc.—according to the locality. About 65 to 70 per cent. of the crude benzol is obtained as finished products—benzene, toluene, solvent and heavy naphthas.

How rapid has been the development of the bye-product coking industry in this country during recent years may be judged from the following official returns of the quantities of ammonium sulphate annually made by such plants, as compared with the corresponding quantities produced in gas-works.

Year	Tons of ammonium sulphate produced in: Bye-product coke-oven plants	Gas-works
1903 ...	... 17,435	... 149,489
1908 ...	... 64,227	... 165,218
1913 ...	... 133,816	... 182,180

In the natural course of events, the final disappearance of the wasteful beehive coking-ovens from this country is now only a matter of a few years; but I venture to suggest that public interest would justify the Government fixing, by law, a reasonable time-limit beyond which no beehive coke-oven would be allowed to remain in operation, except by express sanction of the State, and then only on special circumstances being proved.

There is also much need of a better and more systematic chemical control, in the public interest, of bye-product coking plants. At present, in far too many cases, the chemists employed in coke-oven laboratories are men who have practically no chemical training other than that obtained in evening classes. And, with few exceptions, the chemist, however competent he may be, is entirely subordinated to the directing engineer, and regarded as a mere routine analyst. I can say, from personal knowledge, that plants which are managed and controlled by experienced chemists of broad training, combined with force of character, yield much better results than those which are controlled by men without such qualifications.

And even in this crisis when so much depends on plants working, not only at their maximum output capacities, but also, chemically speaking, under conditions calculated to ensure the highest yields of benzol and toluol, with a proper selection of coal, I doubt whether the measures which have been taken to advise and supervise the coke-oven industry are really adequate from the point of view of chemical control. I do know, for instance, that the experience and resources of the majority of our university departments of applied chemistry which specialise on fuel technology and cognate matters have not been as fully utilised as they might have been in this connection. I cannot for one moment imagine a similar state of things being permitted in Germany, where we may be sure that nothing is being left undone in the way of fully utilising all the available expert chemical and engineering knowledge which can be brought to bear on this important aspect of war munitions; and I venture to say that, whatever may be the case in this country, in Germany at least the staff and resources of no publicly maintained department of fuel technology will not be fully employed on war problems.

The coal-gas industry, which deals with some twenty million tons of coal per annum, has, especially within recent years, shown a growing appreciation of the aid of chemical science, in regard not only to the actual manufacture, but also to the domestic and industrial uses of coal gas. The endowment by the industry, in 1910, of a special chair at the Leeds University, in memory of the late Sir George Livesey (of which I had the honour and pleasure of being the first occupant), was a sure sign of the faith of its leaders in the value of scientific research into its special problems; and, from personal knowledge and intercourse with gas engineers, I can assure my chemical colleagues that any serious interest taken by scientific chemists in these problems, or in training men to tackle them, will be welcomed by the industry, no matter from what quarter such help or interest may come. For although the carbonisation of coal in gasworks is efficiently carried out, no one in the industry supposes that finality has been reached, or that existing methods and conditions cannot be improved under better chemical control.

And, moreover, the gas industry has just recently given a striking example of the public benefit which may accrue from the whole-hearted co-operation of the chemist and engineer in the new nickel-catalytic process for the removal of carbon bisulphide from coal gas, which has been worked out, and brought to a successful issue, by the combined skill and efforts of Mr. Charles Carpenter, Mr. W. Doig Gibb, and Mr. E. V. Evans, of the South Metropolitan Gas Company. They have shown that the sulphur content (as CS_2) of London coal gas can be reduced on a large scale, in regular day-to-day working, from nearly 40 to about 8 grains per 100 cubic ft., without in any way deteriorating the quality of the gas, at a cost (including interest and depreciation) of 0·299*d*. per 1000 cubic ft. Such a striking success was, as Mr. Carpenter acknowledges, only achieved "because of the unrestricted and unreserved collaboration of the chemist and the engineer." Incidentally, the gas industry is to be congratulated on this tacit abandonment of the old contention that coal gas was either none the worse for the presence in it of a certain amount of sulphur compound, or (alternatively), if worse, that a minute amount of sulphur dioxide in the atmosphere of a living room is so rapidly absorbed by the ceiling that its harmful effects are nullified.

As the outcome largely of the work of the Joint Committee appointed in 1907 by the Institution of Gas Engineers and the University of Leeds (of which I was a member) to investigate gas-fire problems, the manufacturers of these appliances have paid much more attention than formerly to the scientific aspects of construction, so far as to ensure the best combination of radiant and ventilating effects, and nearly all the larger firms have now their scientific staffs busily employed in making further advances. Prominent among the pioneers in scientific gas-fire construction has been Mr. H. James Yates, who will to-morrow enlighten you as to some of the most recent improvements. I can, however, from personal knowledge testify to the enterprise shown by most of the leading manufacturers, and that their combined efforts have resulted in a very efficient and perfectly hygienic

domestic gas-fire. A committee appointed by the Institution of Gas Engineers, upon which scientific men are largely represented, is now considering the adoption of a standard method of testing the radiant efficiencies of gas-fires. Thus no one can say that the gas industry is not making every effort to put its affairs upon a thoroughly scientific basis.

Passing on to the metallurgical and allied industries (who, of course, are large consumers of fuel), there is much here to be done in improving the construction and operation of furnaces in order to check the waste of fuel. But of these details there is no time to treat; and one instance of the possibilities of very large economies as the result of scientific control must suffice.

It is perhaps common knowledge that the most economical arrangement of plant for the manufacture of iron and steel is one in which bye-product coke-ovens, blast-furnaces, steel furnaces, and rolling mills are brought together on one site and under one organising direction, so that the surplus gases from the coke-ovens and blast-furnaces may be utilised to the fullest extent. My relative, Mr. T. C. Hutchinson, of the Skinningrove Iron Company, who has devoted many years of anxious thought and practical study to this important problem, ventured some few years ago to predict that—with the most approved type and arrangement of plant, working under strict scientific control by competent chemists—it would soon be possible to make finished steel rails or girders from Cleveland ironstone with no further consumption of coal than is charged into the bye-product coke-ovens for the production of the coke required for the blast-furnace, and all subsequent experience at Skinningrove has fully demonstrated that his prophecy can be fulfilled in everyday practice. Of course, it means a constant watchful control by a well-paid and competent scientific staff under efficient leadership, and in Mr. E. Bury—an old Owens College student, trained in an atmosphere of "gas and combustion"—we have found the very man for the work.

It is perhaps unnecessary, even had time permitted, for me to multiply instances of possible economies in other important directions—such, for instance, as power production and the heating of domestic apartments. There is probably no direction in which equally good results would not accrue with proper scientific application and control as those already cited as having been reached in the direction of carbonisation, or in the iron and steel industry. To-morrow we are to discuss the important subject of smoke prevention, in which many Manchester public men are showing an active interest, so that there will be some further opportunity of referring to the matter.

But may I, in conclusion, appeal in all seriousness to chemists and scientific men generally to take up this important matter effectively as a public duty at this crisis in the country's affairs? I would suggest that the Government be memorialised with a view to the establishment of a central organisation for the supervision of fuel consumption and the utilisation of coal somewhat on the lines of the existing alkali works inspection, which has been so beneficial to chemical industry. And in connection with such an organisation there might be undertaken a much needed systematic chemical survey of British coal-fields, as well as experimental trial of new inventions for fuel economies. There would certainly be no lack of important work for such a properly organised department of the State, and there can be no doubt at all that the results of its activities would be, not only a very large direct saving in our colossal annual coal bill, but also a purer atmosphere and healthier conditions generally in all our large industrial areas.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—In his valedictory address to the Senate, the retiring Vice-Chancellor, Dr. M. R. James, the provost of King's College, stated that the University has shrunk to less than one-third of its former numbers; no fewer than 10,000 Cambridge men have entered the military and naval services. The Rev. T. C. Fitzpatrick, president of Queens' College, was elected Vice-Chancellor for the ensuing year. The Quick professorship of biology is vacant, as the period of three years for which Dr. G. H. F. Nuttall was appointed has now ended.

ALTHOUGH much of the best glass used in England is of English manufacture, large quantities of glass, principally of the cheaper types, have been for some years imported. Cheaper labour, cheaper transport, and the scarcity of technically trained managers and chemists, together with the prevalence of "rule-of-thumb" methods, have been the determining factors. The manufacture of fine glass requires a peculiar combination of engineering, physical, and chemical knowledge and training, and the chemical knowledge is not usually obtainable in university or technical college courses, because of the specialised nature of the subjects and the difficulties which arise in translating laboratory experiments into practice on a manufacturing scale. To meet these difficulties, the University of Sheffield has established a department of glass manufacture and technology, and has instituted special technological courses. A syllabus of special lectures and laboratory work has been issued with details of a projected full-time three years' course. The announcement indicates the variety of scientific and technical work which is essential to a good training in glass manufacture, and includes, *e.g.*, the chemistry of the materials, the glasses and pots, the fuel used, the furnaces, the temperatures at which they work, variations in the methods of melting, chemical actions in the process of melting, methods of working the glass, such as rolling, pressing, and blowing, grinding and cutting, and the machinery and appliances incidental to all these operations. The success of these courses will necessarily depend on the co-ordination of the lectures and the laboratory practice with larger scale experimental work; but the University of Sheffield, with its experience of similar problems in the metallurgical department, should be well qualified to deal with these difficult problems. Their successful solution should be of material assistance to a very important and growing branch of British industry which it is particularly essential to encourage as much as possible at the present time.

THE third war programme in connection with the Chadwick Public Lectures dealing with the last quarter of the present year has now been published. Prof. D. Noel Paton is giving a course of three lectures on "Food in War Time" at the Hampstead Central Library, Finchley Road, London, N.W. The first lecture was given on Monday last, and the others will be given on the two succeeding Mondays, at 8.15 p.m. Dr. R. O. Moon, physician to the Serbian Isolation Hospital at Skoplje (Uskub), will lecture on "Typhus in Serbia," at the Royal Society of Medicine, 1 Wimpole Street, Cavendish Square, London, W., at 5.15 p.m. on October 20 and 29, and on November 3. On November 10, at 8.15 p.m., Mr. A. Saxon Snell will lecture on "Emergency Military Hospital Construction" at the Royal Institute of British Architects, Conduit Street, London, W. On November 17, at 8.15 p.m. Mr. W. E. Riley will lecture on "Some Con-

clusions on Housing our Workers," at the Royal Sanitary Institute, 90 Buckingham Palace Road, London, S.W. The admission to all lectures is free.

THE calendar for the current session of Armstrong College, Newcastle-upon-Tyne, one of the constituent colleges of the University of Durham, is now available. Since August, 1914, the buildings of the college have been in the occupation of the War Office, and the various departments of the college are housed temporarily in different buildings throughout the city. The arrangements for the session follow the general lines of previous years. Complete courses of study leading up to degrees in pure and applied science have been provided. Students who wish to graduate in applied science may take up one of the following branches: general mechanical, marine, civil, or electrical engineering, naval architecture, mining, and metallurgy. Such a degree is accepted by the Institution of Civil Engineers in lieu of their examination for associate membership, and by other corporations. Courses are also provided in preparation for degrees in commerce. A gratifying characteristic of the work done in the college is the active co-operation of employers of labour in the district, who have made it easy for students to obtain experience of workshop conditions during or after their college course.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 27.—M. Ed. Perrier in the chair.—Paul **Appell**: A second form of Θ functions of the fourth degree.—Henry Le **Chatelier** and Jules **Lemoine**: The heterogeneity of steels. An account of the application of an etching reagent proposed by Stead (methyl alcoholic solution of cupric and magnesium chlorides containing hydrochloric acid), with details of the proportions found to give the best results. Nine reproductions of microphotographs accompany the paper.—J. **Haag**: A system of differential formulæ concerning the elements of a projectile submitted to a quadratic resistance of air.—Charles **Rabut**: The calculation of the strength of a beam reinforced with metal bands.—P. **Vaillant**: The laws of flow of liquids in drops. The weight of a drop from a given orifice depends on the number of drops per second. It is proved that the weight of a drop is a parabolic function of the frequency of fall, and experimental data are given in support of this.—P. W. Stuart **Menteath**: The Permian of the western Pyrenees.—Jules **Welsch**: The Pliocene lignites of Bidart, Lower Pyrenees. South of Biarritz there are deposits of lignite the age of which is near to the Middle Pliocene.—R. **Chudeau**: Rain and vapour pressure in western and equatorial Africa.—J. **Bergonié**: A new method of physical treatment of the after results of wounds: pneumatic pulsatory massage. A detailed description of the mode of application of mechanical massage to the treatment of masses of cicatricial tissue. Particulars of the results obtained will be published later.—P. **Portier**: The resistance of certain races of *B. subtilis* arising from insects to chemical reagents. The organisms, isolated from the larva of *Tenebrio molitor* and the chrysalis of *Myeloïs cribrella,* prove to survive very drastic treatment, including 50 hours with 5 per cent. phenol, 25 hours with 20 per cent. formaldehyde, 95 per cent. alcohol more than fourteen months, boiling chloroform, and other reagents. This resistance to chemical reagents is greater than any hitherto observed, and has a direct bearing on the problem of sterilisation of instruments and bandages.—J. **Wolff** and Mlle. Nadia **Rouchelmann**: The properties of a chromogen universally distributed in plants.—A. de la Baume **Pluvinel**: The use of Hughes's induction balance for the detection of projectiles in the wounded.

BOOKS RECEIVED.

Department of Agriculture and Technical Instruction for Ireland. Suggestions for the Teaching of the First Year's Syllabus in Experimental Science for Day Secondary Schools. By E. P. Barrett. Pp. 19. (Dublin: Browne and Nolan, Ltd.)

Armstrong College, Newcastle-upon-Tyne. Calendar, Session 1915–16. Pp. 523. (Newcastle-upon-Tyne: Armstrong College.) 1s.

Five Figure Mathematical Tables. Compiled by E. Chappell. Pp. xvi+320. (London: W. and R. Chambers, Ltd.) 5s. net.

DIARY OF SOCIETIES.

THURSDAY, OCTOBER 7.

EUGENICS EDUCATION SOCIETY, at 5.15.—Eugenics and the Doctrine of the Super-man: Prof. J. A. Lindsay.

FRIDAY, OCTOBER 15.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—The Theory of Grinding, with reference to the Selection of Speeds in Plain and Internal Work: J. J. Guest.

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THURSDAY, OCTOBER 14, 1915.

BEAUTY AND DESIGN IN NATURE.

(1) *Genetic Theory of Reality: being the Outcome of Genetic Logic as Issuing in the Æsthetic Theory of Reality called Pancalism.* With an extended glossary of terms. By Dr. J. M. Baldwin. Pp. xvii+335. (New York and London: G. P. Putnam's Sons, 1915.) 7*s.* 6*d.* net.

(2) *The Natural Theology of Evolution.* By J. N. Shearman. Pp. xv+288. (London: George Allen and Unwin, Ltd., n.d.) 10*s.* 6*d.* net.

(1) THIS book cannot be adequately reviewed without embarking more or less on an examination of the distinguished author's whole system as largely presented in his earlier monumental works. Moreover, being concerned with technical philosophy—though a philosophy which accepts and includes science—its appeal is primarily to readers other than those of this journal. It will suffice, therefore, to indicate briefly its scope and purport. The essence of the pancalistic doctrine is its emphasis on beauty. Science tells us what is true; that is science's prerogative. But the universe has beauty and goodness as well as truth. How reconcile and unify? The pancalistic answer is that the good and the true is so because it is beautiful. The final court of appeal is æsthetic. Nothing can be true without being beautiful, nor anything that is in any high sense good. The ascription of beauty, a reasoned, criticised, thought-out ascription of æsthetic quality, is the final form of our thought about nature, man, the world, the all. The volume under notice is an unfolding of this idea, dealing with the aspects of morphology, interpretation, religion (mysticism), and logic.

(2) An excellently written but somewhat diffuse restatement of Paley's argument for design. The author points out that the work of Darwin and his successors does not rule out design; it only requires the supposition that the designing mind works slowly, experimenting through many ages. As to those variations which have turned out failures—the flying reptiles and other extinct creatures of earlier periods—the author makes the suggestion that the direction of variation may to some extent be deputed by God to angels, in the same way as free-will and power is granted to man; and that these failures are the experiments of the angel-subordinates. But the author is not in the least a crank, and he puts forward this fresh and interesting hypothesis (which some would call fantastic) as a speculation only. His main point is that though the Darwinian natural selection is a true cause of change in species, the variations which tend to progress and greater complexity cannot be attributed to chance. They are evidence of a guiding mind which sees and knows before it produces on the material plane.

This, and the accompanying question of what we mean by "chance," is an extremely thorny problem, as the author indeed recognises. His treatment of it is lucid, sincere, and able, whether readers fully agree with it or not. Certainly there is a greater tendency among men of science at the present day to accept a philosophy of Platonic or idealistic type—which looks on Mind as the *prius,* and the material world a manifestation thereof—than at any time since modern scientific method appeared; and to many this very interesting volume will be welcome and useful. It deserves to be widely read.

LIME-SAND BRICKS AND ALLIED PRODUCTS.

Bricks and Artificial Stones of Non-plastic Materials: their Manufacture and Uses. By A. B. Searle. Pp. vi+149. (London: J. and A. Churchill, 1915.) Price 8*s.* 6*d.* net.

AS intimated by the author in the preface, this book is intended: "(*a*) to supply reliable and unbiased information to those firms and individuals who contemplate making or buying bricks and artificial stones from non-plastic materials; (*b*) to assist manufacturers in solving the problems which occur in the course of their work, to enable them to remedy defects and to avoid other technical difficulties." In proceeding to carry out these objects, Mr. Searle treats in some detail the modes of production and uses of lime-sand bricks, clinker bricks, slag bricks, bricks made of crushed rock, concrete bricks and blocks, and various types of artificial stone, etc. As he points out, these products can often be made advantageously in districts where the manufacture of burnt bricks and tiles would be impracticable. Thus in some places the absence of suitable clay, or the want of a readily available supply of coal, would render any attempt to make bricks unprofitable; whilst, on the other hand, the presence in such a district of abundant deposits of sand might make the manufacture of lime-sand bricks perfectly feasible from a commercial viewpoint. It is even practicable in some cases for the two classes of products to be made side by side, the sand frequently found overlying the brick clays being beneficially utilised for the production of lime-sand bricks instead of being simply put away as so much waste material of no value.

A considerable amount of attention and space is devoted to a description of the raw materials,

with their favourable and unfavourable characteristics, methods of preparing and mixing the ingredients (including some brief historical notices), the process of pressing, and the final process of hardening. The subjects of cost, of manufacture, and defects are dealt with in special chapters, as are also the physical properties of the products. The work is embellished with numerous illustrations depicting machinery and appliances suitable for properly carrying out the different kinds of operations.

Much of what is contained in the volume is based partly on the author's personal experiences, and partly on such experiences of other people as have come under his notice. This is in itself a highly commendable feature, but the author's confidently expressed opinions, assuming them to be well-founded, would lose none of their weight if the experimental data on which they are based were set forth more frequently than is the case.

There are a number of misprints, some of them trivial, but several may give rise to much doubt and perplexity. Apart from mere misprints, there are some loosely worded statements which would scarcely be expected from such an experienced writer as Mr. Searle appears to be, judging from the number of his published works. Thus, near the bottom of page 26, we are told that "the three essential ingredients—aggregate, lime, and water—*must be:* (1) *Ground* to the requisite fineness and graded (if necessary). (2) *The proper proportion* of each must be weighed or measured. (3) *Mixed* to form a homogeneous mass in which the lime is fully hydrated." The italics here are, of course, not the author's. Comment is scarcely necessary. It is not suggested that the meaning is obscure, but in quasi-scientific works on technical subjects there should be no flagrant flouting of grammatical rules. On page 82, line 18, 7 per cent. is mentioned instead of 0·7 per cent. There seems no valid reason for the spelling, in some of the later chapters, of "absorbtion" instead of the more orthodox "absorption." A curious mistake occurs at the bottom of the table on page 120, where the "cost of manufacture" of "cement-sand bricks" is stated to be "1 month." In the last sentence of the second paragraph on page 10, owing presumably to displacement of a comma, an absurd statement is made. It is true that the real meaning is rendered clear in the following paragraph, but a practised writer ought surely to guard against such slips.

The present writer has arrived at the conclusion that the author is less assailable as regards his treatment of the practical aspects of his subject than when dealing with more speculative questions. Thus, after giving in a tentative way the results of an analysis of the cementing material in non-plastic bricks, and suggesting a formula to correspond, he proceeds to apply this formula in a chemical equation to explain the reaction by which such cementing material is formed. The statement which accompanies it may constitute a fairly accurate general account of what takes place; but although more than one "if" is expressed or implied in the explanatory sentence, the equation somehow seems to suggest a more intimate knowledge of this particular reaction than is justified by the actual facts, as the author himself distinctly states more than once that the composition of the binding material is not definitely known. Again, in criticising the results of experimental work of F. F. Wright, performed at the Carnegie Institute, Mr. Searle goes so far as to assert that "if F. F. Wright had worked on a large scale and with better facilities, he would probably have realised that his experiments afford a much stronger confirmation of the composition suggested by the author of the present volume than they do of the existence of a zeolite, as the latter, so far as is known, do not possess cementitious properties." This may seem convincing to the author, but to a trained mind the conclusion is very far from being established, even when taking into account the experimental evidence by which he plausibly claims to prove the general accuracy of his conclusion.

With some reservation as regards certain of the matters to which attention has been directed, the work should prove useful for the objects the author had in mind when preparing it. One excellent feature worthy of mention is the comparison table occasionally introduced, showing in one view a number of more or less different processes, or the properties of a variety of different products, etc. There is also a serviceable index.

J. A. A.

THE PANAMA CANAL.

The Panama Canal: Comprising its History and Construction, and its Relation to the Navy, International Law, and Commerce. By R. E. Bakenhus, Capt. H. S. Knapp, and Dr. E. R. Johnson. Pp. xi+257. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1915.) Price 10*s.* 6*d.* net.

THIS book has a claim to authority. It consists essentially of a series of papers which were originally published in the Proceedings of the United States Naval Institute. Of the three authors the first, Mr. Bakenhus, is a member of the Corps of Civil Engineers of the United States Navy, the second, Capt. H. S. Knapp, U.S.N.,

was formerly member of the Naval War College Staff, and the third, Dr. Emery Johnson, is special commissioner on the Traffic and Tolls of the Panama Canal.

Mr. Bakenhus narrates the history of the project, and gives a clear account of the design and construction of the canal. His treatment of the phenomena presented by the landslides is, however, inadequate, and not marked by any originality of thought. They still occur at intervals, seriously reducing the depth of the waterway; it is quite uncertain when they will cease, and until that time comes the canal will not be thoroughly satisfactory as a link in the chain of naval communication between the Atlantic and Pacific Oceans.

Captain Knapp deals with the United States Navy and the Panama Canal, detailing the reductions of sea distance. The strategic aspect of the canal has not received sufficient attention in this country, considering that it was primarily intended for the use of the United States Navy. But if the British public has been in the past somewhat prone to neglect the study of strategy, our condition is one of enlightenment compared to the general misapprehension of such matters by American citizens.

"The United States," says Capt. Knapp, "is not a military nation. There is little consideration and less understanding among the people at large of military matters. The Government has no defined military policy, using military in its wide sense, and it has no defined naval policy."

The plain fact is that the American Government is gambling on the maintenance of the balance of power in Europe. Once let the balance of forces on our side be destroyed and the Monroe doctrine could not be upheld by the naval and military force now at the disposal of the United States, and the whole fabric of American imperial policy would fall. The time which would be required to prepare the United States for war with great Powers is probably under-estimated by most people. The first step must be the education of the people to its necessity, which necessarily takes time. The creation of an adequate staff of trained officers for a large army also takes time; and the building up of a merchant marine, so much required for the navy, is an extremely difficult problem in view of the economic conditions in America.

If the Government of the United States began to-morrow to prepare for a serious war we do not think that the country would be ready in less than twenty years. It is earnestly to be hoped in the interests of Anglo-Saxon civilisation that the great and patriotic democracy of America will turn its keen intelligence to the study of war. V. C.

OUR BOOKSHELF.

Refuse Disposal: a Practical Manual for Municipal Engineers, Members of Local Authorities, etc. By E. R. Matthews. Pp. xiv+160. (London: C. Griffin and Co., Ltd., 1915.) Price 6s. net.

"It is the purpose of this work to set forth modern methods of collection and disposal, embodying the latest practice, so as to enable the municipal engineer and the local councillor to see what is being done in this and other countries"; and information of the type usually accumulated by local authorities in their consideration of the problem of refuse disposal is presented in large quantity having regard to limitations of space.

Given a sound knowledge of the general principles and practice, the engineer will find the collected data with regard to typical plants serviceable, but for the councillor some assistance to the intelligent application of the information presented might well have taken the place of certain non-essential detail and superfluous photographs.

"Discussion" of the advisability of installing destructors for small communities, promised in both preface and text, resolves itself into a description of certain destructors employed in works and institutions, and the statement that destructors "are equally useful for a village of five hundred population as for a city of 500,000."

The bearing upon the cost of disposal, of the special difficulties of collection, of the provision of adequate attention at the destructor, and of finding any practicable use for the heat generated, in a "village of five hundred population" as compared with a city or even an institution, is apparently unrecognised.

The book deals with the uses of destructor clinker and the construction of chimneys, and concludes with some interesting notes upon the principles of vacuum cleaning and dust collecting.

P. G.

A List of Geographical Atlases in the Library of Congress, with Bibliographical Notes. Compiled under the direction of Philip Lee Phillips. Vol. iii. Titles 3266–4087. (Washington: Government Printing Office, 1914.)

The first two volumes of this valuable work were reviewed in NATURE in 1910 (vol. lxxxiv., p. 325), and as the same general plan and arrangement are followed in vol. iii., a brief notice of this will suffice. It deals almost entirely with acquisitions by the Library of Congress since 1909, but such are the resources at the disposal of this fortunate institution that the present list reaches more than half the bulk of the earlier one. In part this may be due to the somewhat fuller notes and analyses—a feature of great value—but the additions to the collection are extraordinarily numerous and important. They include, *e.g.*, copies of Lafreri's rare Italian atlas, and of Waghenaer's "Speculum Nauticum," the absence of both of which was commented on in our previous notice. But few copies of Lafreri, with title, are known, and no two are quite alike; so that the careful collation now given, and the comparison with Norden-

skiöld's list, will be a boon to students, especially in conjunction with the comparative table of maps in other known copies—one in the collection of the Royal Geographical Society—lately supplied by Dr. Wieder, of Amsterdam. Other additions are the rare first edition of Ortelius, and six further editions of Mercator. The most complete of the latter (1639), of which a copy was lately acquired by the Royal Geographical Society, is not, however, to be found, any more than in our own national collection. We still miss a much-needed guide to the arrangement in the form of page-headings.

Lord Kitchener and his Work in Palestine. By Dr. Samuel Daiches. Pp. 88. (London: Luzac and Co., 1915.) Price 2s. 6d. net.

THIS lecture will serve admirably to acquaint the general reader with a little-known aspect of Lord Kitchener's great capacity. His Palestine exploration work falls in the years 1874 to 1878, and the success which attended it revealed him as a successful surveyor, a scientific observer, and a writer of convincing and trustworthy reports. The book provides an interesting and instructive account of his contributions to our knowledge of the geography, geology, and natural history of Palestine.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Manganese-Ore Requirements of Germany.

PROF. CARPENTER, in his article on "Munition Metals" in NATURE of July 15, gives estimates of the resources of the enemy countries in the metals required for war purposes. This information will doubtless prove of great value, especially to those whose duty it is to study the weak points in the armour of our enemies and to devise methods of accentuating those weaknesses; it is consequently desirable that the information so gathered together should be as accurate as possible. In summing up, Prof. Carpenter states that the enemy countries can certainly produce five out of the ten metals considered, without having recourse to imports, these five being iron, manganese, chromium, zinc, lead; whilst he regards it as doubtful whether they can produce from domestic sources sufficient of the remaining five metals—nickel, copper, aluminium, tin, and antimony.

In the course of a lecture delivered in Calcutta recently I had occasion to review the situation as regards manganese-ore, and arrived at the conclusion that the internal resources of the enemy countries in manganese-ore were inadequate to supply more than a small proportion of the internal requirements; so that in my opinion manganese should be transferred to the second group of metals noticed by Prof. Carpenter. Consequently it seems that a short review of the facts of the case will not be out of place

In the following table are collected statistics stated in metric tons of the steel production of the world, of Germany, and of Austria-Hungary, the manganese-ore production of the world, and the manganese-ore secured by Germany, and by Austria-Hungary, for each of the eight years 1906 to 1913:—

(*In Metric Tons.*)

Year	The World		Germany		Austria-Hungary	
	Steel production, in millions of tons	Manganese ore production, in thousands of tons	Steel production, in millions of tons	Manganese ore secured, in thousands of tons	Steel production, in millions of tons	Manganese ore secured, in thousands of tons
1906	49·64	1,932·8	11·14	328·6	1·20	57·4
1907	51·27	2,334·9	12·06	389·7	1·20	96·8
1908	44·36	1,353·6	10·48	331·8	2·03	63·1
1909	53·50	1,576·5	12·05	379·9	1·97	79·9
1910	58·66	1,835·4	13·70	483·3	2·19	92·7
1911	58·27	1,516·7	15·02	411·1	2·36	112·5
1912	72·7	1,640·8	17·87	515·3	2·79	89·7
1913	75·8	2,426·0	19·29	671·0	2·68	96·7
Totals	464·2	14,625·7	111·61	3,510·7	16·42	688·8
	3·15 tons of manganese ore per 100 tons of steel.		3·15 tons of manganese ore per 100 tons of steel.		4·20 tons of manganese ore per 100 tons of steel.	

Note.—These figures are based on statistics given in the "Mineral Industry." [See also "Records, Geolog. Survey, India," xlvi. pp. 144 145, (1915)]. The German "Manganese-ore secured" is the excess of imports over exports, the German "Manganese-ore" being excluded as referring mainly to manganiferous iron ore, which is excluded from this table. The Austrian "Manganese-ore secured" is the excess of production *plus* imports over exports.

From this we see that the German steel industry has shown a remarkable expansion, and that consequently in order to estimate the German requirements we should use only the most recent statistics. In the three years 1911 to 1913 Germany produced an annual average of 17·4 million tons of steel, and secured possession of an annual average of 622,400 tons of manganese-ore, of which 532,500 tons were imported chiefly from Russia and India, and the balance of about 90,000 tons (consisting, by the way, not of high-grade manganese-ore, like the imported material, but of manganiferous iron-ore) was won in Germany.

Turning to Austria-Hungary, we find that during the same three years she produced an annual average of 2·61 million tons of steel, and secured possession of 100,200 tons of manganese-ore, of which 69,400 tons were imported and 30,600 mined within the empire (including Bosnia-Herzegovina).

Assuming, therefore, that the two Teutonic empires require approximately as much manganese-ore when at war as in times of peace, it is evident that they have to provide 532,500 + 69,400 = 601,900 tons of ore to replace their imports in time of peace. There are four possible sources to be considered:—

(1) A development of internal resources.

(2) Imports from their ally Turkey, which posseses manganese-ore deposits.

(3) Imports from neutral countries.

(4) Accumulated stocks.

(1) A consideration of the German deposits of manganese-ore as at present described shows that they are all of small importance. The manganese-ore usually occurs either in irregular lenticular or nodular deposits, or in thin veins, in no case in sufficient quantity to permit of work on a really large scale, whilst a large proportion of the so-called manganese-ore is of very low grade, and more aptly termed manganiferous iron-ore. It does not seem probable that Germany could increase her annual average production of 90,000 tons by more than a few tens of thousands of tons.

The deposits in Austria-Hungary (especially in Bosnia) contain some high-grade managanese-ore, but the published accounts of these deposits do not indicate that an annual production of a little more than 30,000 tons could be increased to several times that amount.

Perhaps by intense activity the Teutonic empires

might increase their output of manganese-ores and manganiferous iron-ores by 100,000 tons annually, but this seems exceedingly unlikely, both from the character of the deposits and from the fact that in times of peace the existence of a large market for manganese-ore must have created every incentive towards intensive working of the domestic manganese-ore deposits.

(2) Turkey is known to have manganese-ores at several localities, but information is very scanty. Of recent years no production has been reported, but a few years ago Turkey produced from 14,000 to 49,000 tons of ore annually. Of the producing localities the only one mentioned in Turkey-in-Europe was the Cassandra district, which is now part of Greece. In Asia Minor manganese-ores have been worked in the provinces of Trebizond and Aidin. In view of Russian naval activity in the Black Sea and the absence of railways, the Trebizond ores must be cut off from Constantinople. Aidin is, however, connected to Constantinople by rail *viâ* Smyrna, and ore from this region could consequently be forwarded, as long as through traffic is permitted at Smyrna by the Allies. But as the Aidin ores are reported to occur in pockets in limestone, no considerable development in this area seems possible. Ores have also been reported as occurring at one or two localities in the country to the south of the Sea of Marmora, and might supply a certain quantity of ore for shipment to Constantinople. Considering, however, the undeveloped state of Asia Minor and the bad communications, it seems improbable that Turkey will be able to aid her allies to any marked extent.

(3) The third possible source of manganese-ore is imports from neutral countries. Now by far the larger proportions of the world's output of manganese-ore comes from three countries, namely, India, Russia, and Brazil, which during the five years 1908 to 1912 (I have not yet been able to obtain complete figures for 1913) contributed respectively 43·8 per cent., 37·2 per cent., and 12·5 per cent., totalling 93·5 per cent. of the world's total production.[1]

The export of Indian ore is prohibited to all destinations except the United Kingdom and France; the export of the Russian manganese-ore to enemy countries is doubtless prohibited, whilst the hard facts of the geographical situation prevent its export to all neutral countries except Rumania and Bugaria,[2] and we can trust our Allies to see that no managanese-ore finds its way to Germany and Austria through this route. There are two reasons why Germany and Austria cannot fall back on Brazil for their supplies of manganese-ore, namely, the British Navy and the fact that Brazilian ore must be more than ever in demand in the United States of America, always its chief customer, now that America is cut off from the Indian and Russian supplies, for the United States, as pointed out in the footnote, has no domestic manganese-ore supplies of her own worth mention.

[1] Prof. Carpenter overlooks the Brazilian production, amounting roughly to 200,000 tons annually, and names the United States of America as one of the three chief producers of manganese-ore in 1913, whereas the 1913 production of the United States of America was the insignificant amount of 4048 tons out of the world's total production of over two million tons. This error is doubtless due to a misleading habit on the part of certain American compilers of statistics of including manganiferous iron-ores under the term manganese-ore. This manganiferous iron-ore production ranges from five to nine hundred thousand tons annually, but the percentage of manganese present in this iron-ore is only from 2 to 20, and such ore cannot be regarded as a manganese-ore, is doubtless never sold as such, and must be excluded from the world's totals of manganese.ore production. Another slight error has also crept into Prof. Carpenter's article: he states, referring to the production of Russia, India, and the United States of America, that "the raw material is pyrolusite, a 'straight' manganese-ore corresponding when pure to MnO_2." This is true only of the Russian ore; the American ore referred to is a manganiferous hematite, whilst the Indian ore is of mixed mineralogical composition. Although some of the Indian manganese-ore is pyrolusitic, by far the larger proportion is a mixture of braunite and psilomelane, whilst in some localities hollandite is an important ore.

[2] [Since this letter was written, Bulgaria has ceased to be a neutral country.—ED.]

The 6·5 per cent. of manganese-ore not produced by the three countries mentioned is obtained from Austria-Hungary, Spain, Japan, Greece, France, the United Kingdom, Sweden, and Italy. Of the three neutral countries amongst those enumerated, Sweden is the only one conveniently situated for Germany. The Swedish annual production is a little more than 5000 tons, and, judging from observations made during a visit to the Swedish manganese mines, I should say that the Swedish production was capable of but very small expansion. Manganese-ore deposits are also known to occur in Bulgaria, but they are of low grade and small extent, so that they could not prove of much value. It seems evident then that Germany and Austria cannot find salvation in neutral countries.

(4) As the three possible sources already considered do not appear to hold out hope that Germany and Austria could obtain their peace requirements of manganese-ore in time of war, it is possible that the enemy countries made provision for this disability by accumulating large stocks of manganese-ore in times of peace. Whether this has been done or not can be deduced only indirectly. From the table on p. 170 we see that during the years 1906 to 1913, taking the world as a whole, 3·15 tons of manganese-ore were produced for every 100 tons of steel made, whilst curiously enough the figures for Germany alone for the same period show that that country received exactly the same proportion of manganese-ore per 100 tons of steel, namely, 3·15 tons.

Assuming that German metallurgy requires for its various purposes as high a percentage of manganese as the rest of the world, it seems reasonable to deduce from the foregoing figures that Germany actually consumed most of the manganese-ore received during the eight years in question, and that therefore by the end of 1913 she could not have accumulated any considerable stocks of manganese-ore. I must note that in making the above calculations I have excluded figures for manganiferous iron-ores from both the German and world's figures[3] as confusing the issue. During the eight years in question, however, the German total production of so-called manganese-ore (mostly manganiferous iron-ore) was 622,500 tons. But there is no reason for regarding this figure as a measure of accumulated stocks. It is instead rather a measure of the fact that Germany really requires a higher amount of manganese-ore per 100 tons of steel produced than most countries, owing to the necessity of adding manganese-ore or manganiferous iron-ore to the blast-furnace burden in smelting the sulphurous phosphoric minette iron-ores of Lorraine. During the same eight years, 1906–13, Austria-Hungary obtained 4·20 tons of manganese-ore for 100 tons of steel made. I have no information available to show whether or not there are any peculiarities in Austrian metallurgy requiring the use of a larger amount of manganese-ore than usual. If there are not, then these figures suggest an accumulation of stocks to the extent of about 175,000 tons by Austria by the end of 1913. The conclusions arrived at are admittedly open to considerable doubts, but it seems probable that by the end of 1913 the Teutonic Powers had not accumulated more than 200,000 tons of manganese-ore, and possibly considerably less.

At present I have been unable to obtain statistics relative to German imports of manganese-ore in 1914, except that there was nothing abnormal in the amount sent from India up to the outbreak of war. Had

[3] Manganiferous iron-ores are produced by the following countries:—

	Average for 1908–12
United States of America	686,302 metric tons
Germany	81,040 ,,
Greece	41,842 ,,
Italy	15,165 ,,

Germany purchased abnormally from Russia during the first seven months of 1914 the fact would probably have been reflected in an increase in the price of manganese-ore during the year. As a matter of fact, the price per unit of manganese-ore fell steadily from a maximum of 12 to 12½ pence in January, 1913, to 9¼ to 9½ pence in July, 1914.

From what precedes it seems justifiable to conclude (*a*) that on the outbreak of war the Teutonic Powers had no great accumulated stocks of manganese-ore, perhaps a maximum of 200,000 tons; (*b*) that, assuming war conditions necessitate a maintenance of the iron and steel industries of those two countries at a peace standard, about 600,000 tons of ore a year must be obtained from fresh sources to replace imports in time of peace; (*c*) allowing that the Teutonic Powers might succeed in increasing their internal production by 100,000 tons and obtain 50,000 tons of manganese-ore from Turkey, if the Allied fleets could prevent all manganese-ore from outside from reaching Germany and Austria these countries would be faced with a shortage of 250,000 tons of manganese-ore in the first year of war, and with a shortage of 450,000 tons per year afterwards, increased to 500,000 tons per annum once the Dardanelles are forced.

The Germans will doubtless find means of dispensing with the use of manganese-ore as much as possible, and they may devise methods of utilising the manganese silicate, rhodonite, of which they appear to possess a considerable quantity; but it seems inevitable that the shortage of manganese-ore, once it is felt, will hamper seriously the German iron and steel industries.

It appears therefore to be of the utmost importance that every effort should be made by the Allied fleets to prevent smuggling of manganese-ore (or ferro-manganese and spiegeleisen) into Germany and Austria, either direct or through neutral ports. It is to be noted that of the small countries adjoining the enemy countries the only one manufacturing iron and steel is Sweden, which does not show either manganese-ore, ferro-manganese, or spiegeleisen, amongst her imports in normal years.

L. LEIGH FERMOR.

Calcutta, September 2.

Jupiter's Two Principal Markings.

AT intervals during the work of a comparison of stellar magnitudes, the 26-in. reflector has been turned on Jupiter, in order to determine the present rotation period of the various surface currents, and it is hoped that results of some value will be obtained by the end of the present apparition. The following longitudes, based on transit estimates, of the two most important objects on Jupiter, viz., the S. Tropical Disturbance and the Red Spot Hollow, have been determined:—

S. Tropical Disturbance

Date 1915	P. end	f. end
Sept. 11	28·3°	—
13	25·9°	—
20	23·5°	—
21	—	117·7°
26	—	112·8°
28	—	111·6°
30	20·4°	110·4°
Oct. 1	—	109·7°

Red Spot Hollow

Date 1915	P. shoulder	f. shoulder
Sept. 10	—	260·2°
12	224·6°	—
17	224·3°	261·2°
19	224·1°	262·8°
27	—	260·2°
29	—	260·2°

The S. Tropical Disturbance is more than 90° in length at the S. equatorial belt, and in point of size forms a wonderful object when centrally on the meridian. Its length is such as to extend nearly from limb to limb. It first appeared as a comparatively small object in the spring of 1901, and although in the meantime it has fluctuated in size considerably, it exhibits no signs of decadence.

When the air is steady, the Red Spot can be seen without difficulty in the 26-in. reflector. It is, however, well to state that it is now no more distinct than it has been for many years. Displaced towards the f. side of the Hollow, its following end coincides almost with the longitude of the f. shoulder of the Hollow, while its northern contour is nearly in line with the S. edge of the S. equatorial belt. It will be seen from the above longitudes that the length of the Hollow is roughly 38°, a similar dimension having obtained during the last fifteen years.

October 2. SCRIVEN BOLTON.

The Orionid Meteoric Shower.

THE ensuing return of these meteors will deserve, and probably will repay, observation. The moon will be full on October 23, and will somewhat interfere with the display, but it is rather a long-continued one, and may be favourably witnessed in the mornings from about October 17–21 before sunrise.

From a great many observations made at Bristol, and which I have recently discussed, I believe that the shower extends from the first week in October to the first week in November. I have determined two radiants, as follows, from my collected materials from 1873 to the present time:—

October 3–12—91¼° + 14½°; 10 meteors.
October 25–November 7—92½° + 14°; 18 meteors.

For the intervening period between October 12 and 25 I have a number of radiants of this well-known and annually recurring shower. The two radiants given above are adequately supported by a sufficiency of streaking meteors, and I believe represent genuine positions, but it cannot absolutely be proved that they are based on the flight of true Orionids. Remembering, however, that the radiation is from a fixed point at about 92° + 15° for certainly a fortnight near the maximum, I believe I am justified in ascribing a month's activity to the shower. It would be serving a useful purpose if observers watched the display very carefully this year, and ascertained the place of the radiant point accurately between, say, October 15 and 25. The fact of this stationary radiant would then be no longer open to criticism.

W. F. DENNING.

44 Egerton Road, Bristol, October 8.

Visibility of Distant Objects in Warfare.

I WAS much interested in the article on "Visibility of Distant Objects in Warfare" in NATURE of September 30. The question is of vital importance to many who, like myself, spend much of our time in artillery observing stations.

I believe a good deal of misconception exists as to the reasons why the Germans use various-coloured sandbags. It may be that their use is intended to make for invisibility, but I am inclined to think that it is primarily due to their lack of materials for making sandbags. They lack jute, and are consequently forced to make use of the stocks of various-coloured dress materials, in some cases indeed using the uniforms they have taken from the bodies of any men who may have been killed near their trenches. It is interesting to note that the colour most commonly employed in making their latest sandbags is a pinky-red.

In dealing with the question of visibility, it seems to me that the whole tendency in designing uniforms and in making fortifications is to ignore the important consideration of shadow, which Thayer has shown to have such an important bearing on the coloration of animals.

I have hopes that your article may induce some man of science to take the matter up, and perhaps submit his conclusions confidentially to Lord Fisher's Commission.

ARTILLERY OBSERVING OFFICER.

October 6.

Distances at which Sounds of Heavy Gun-firing are Heard.

IN NATURE of September 30 I see a letter from Dr. Henry de Varigny on the above subject. It reminds me of September 2 last year, when I noted in my diary:—"The day here (400 ft. elevation on scarp of the Lower Greensand overlooking the Weald) was brilliantly fine and warm, without a cloud, South Downs misty, a gentle wind from the south-eastward. My sister heard very distant continuous rumbling, like guns, all the morning up to 1.30, and several times mentioned it when sitting in the garden; my coachman and a maid-servant also heard it. What was going on that day in France it would be interesting to know; there was no gun-firing on the coast of Sussex." I wrote, after taking bearing on map:—"It may possibly be as far as 150 miles to Amiens." I find twice since, and only a fortnight ago, similar continuous rumbling has been heard, but unfortunately the date not noted. I am much too deaf to hear such sounds myself. H. H. GODWIN-AUSTEN.

Nore, Godalming, October 1.

THE only papers on this subject with which I am acquainted are the following:—(1) The distance to which the firing of heavy guns is heard, NATURE, vol. lxii., 1900, pp. 377–79; (2) the audibility of the minute-guns fired at Spithead on February 1, *Knowledge*, vol. xxiv., 1901, pp. 124–25. Reference might also be made to NATURE, vol. xli., 1890, p. 369, and vol. lx., 1899, p. 139. The firing during the funeral procession of the late Queen Victoria was heard to a distance of 139 miles from Spithead. There is therefore no reason why firing along the Belgian coast should not, with favouring winds, be heard for many miles inland from our coasts. The air-vibrations affect pheasants and other birds (probably by swaying the branches of trees) for some distance after they cease to be perceptible to the human ear, as was widely observed on the occasion of the North Sea battle on January 24. I would suggest that observations of this kind should also be forwarded to Dr. de Varigny.

I may add that the literature relating to explosions is more extensive and much more valuable than the above. Prof. Omori's memoirs on the eruptions of the Asama-yama (Bull. Imp. Earthquake Inves. Com., Tokyo, vol. vi., 1912, pp. 1–147, and vol. vii., 1914, pp. 1–215) contain many interesting observations. A few cases of recent explosions in factories are noticed in NATURE, vol. lxi., 1899, pp. 91–92, and *Knowledge*, vol. i., 1904, pp. 94–95. Mr. S. Fujiwhara has lately published a valuable memoir on the abnormal propagation of sound in the atmosphere (Bull. of the Centr. Meteor. Obs. of Japan, vol. ii., pp. 1–143). This contains a mathematical discussion of the problem, with special reference to the observations recorded by Prof. Omori. References to recent German literature on the subject are also to be found in this memoir.

CHARLES DAVISON.

16 Manor Road, Birmingham.

The late Prof. E. A. Minchin on "The Evolution of the Cell."

PROF. E. A. MINCHIN was looking forward with interest at the time of his death to distributing the "extra prints" of his Manchester address, which was three times as long as will appear in NATURE. These "extras" are now in my possession, but I have no means of getting Prof. Minchin's "list." I shall be very happy to send a copy to anyone who will send me a postcard asking for it.

EDWARD HERON-ALLEN.

Large Acres, Selsey Bill, Sussex, October 12.

DEATH FROM STATIC CHANGES IN ATMOSPHERIC PRESSURE.

AS mentioned in a note in NATURE of July 8 (p. 515), M. R. Arnoux has found that a momentary diminution of at least 350 mm. of mercury in barometric pressure may be produced within three metres of a bursting high-explosive shell; and he suggests that the sudden diminution of pressure may cause death by the liberation of gas-bubbles in the blood, and consequent blocking of the circulation.

In his book on "La Pression Barométrique," published nearly forty years ago, Paul Bert proved that the various symptoms which often follow decompression from high atmospheric pressure are due to liberation of gas-bubbles in the blood or tissues. In diving work, and various kinds of engineering work under water or in water-bearing strata, men are exposed to high atmospheric pressure. During the exposure the blood passing through the lungs takes up in simple solution an extra amount of gas in proportion to the increased partial pressure of each gas present in the lung air. The gases present are oxygen, carbon dioxide, and nitrogen. The extra free oxygen taken up is, however, very small in amount as compared with the total free and combined oxygen taken up at normal atmospheric pressure; and since much of this total is used up as the blood passes through the tissues, there is no appreciable rise in the very low partial pressure of oxygen in the blood of the systemic capillaries or veins or in the tissues. There is also no rise in the low partial pressure of carbon dioxide in the lung air or blood, since the breathing is so regulated as to maintain a practically constant partial pressure of carbon dioxide in the lung air. On the other hand, the partial pressure of nitrogen in the blood leaving the lungs rises in proportion to the increased atmospheric pressure, and as no free nitrogen is used up, every part of the body becomes gradually saturated with nitrogen at this increased partial pressure. If, now, the atmospheric pressure is again reduced to normal, the blood and semi-liquid tissues of the body are left in a condition of super-saturation with nitrogen, and as a consequence bubbles, consisting almost entirely of nitrogen, are apt to form, and to cause very serious effects. Death may result from blockage of the circulation through the lungs or heart-muscle; paralytic attacks may be caused by blockage in the brain or spinal cord; while characteristic localised pain (so-called "bends") may be produced by the presence of bubbles elsewhere.

It is clear that if the atmospheric pressure is considerably diminished from normal, a similar condition of super-saturation of the body with nitrogen will exist, so that bubbles may be formed; and it is natural to suspect that a sudden, though only momentary, diminution, due to the bursting of a shell, might liberate bubbles. There are, however, facts which tell strongly against this hypothesis.

In the first place, it must be pointed out that

a considerable interval of time elapses between decompression and the onset of symptoms due to bubble-formation. It is commonly fifteen or twenty minutes, and often far more, before the appearance of symptoms caused by bubbles after rapid decompression from a high atmospheric pressure. Sudden effects, such as those said to be produced by bursting shells, are never observed, however rapid the decompression may have been. The formation of bubbles of sufficient size to do any harm is evidently a process which takes considerable time. A momentary decompression, even if it were extreme, could scarcely, therefore, have any serious effect.

If, however, minute bubbles were formed, they would rapidly disappear again when the momentary wave of negative pressure had passed. Abundant experience has shown that there is no more rapid and certain means of treating the symptoms due to bubbles than recompression. When men who have come out of compressed air are affected, they can be relieved by returning them to the compressed air from which they came, or placing them in a medical recompression chamber provided for the purpose. As an instance of the application of this treatment, a recent case may be recorded of a naval diver who, owing to some emergency, had returned to surface suddenly, without carrying out the prescribed regulations for safety. About twenty minutes afterwards he became ill, lost consciousness, and was apparently dying from bubble formation. In accordance with the recommendations for dealing with such a case, in the absence of a re-compression chamber, his helmet was screwed on, and he was then lowered to the depth from which he had come. He recovered consciousness rapidly, and was soon able to answer the telephone, after which he was safely brought up, with due precautions. In the case of a man exposed only momentarily to decompression, the remedy for bubble-formation is, of course, automatically applied at once, since he returns at once to the pressure from which he was decompressed.

Recent investigations in this country have shown that symptoms due to bubble-formation do not occur unless the absolute barometic pressure is diminished by more than half. Thus it is safe to decompress rapidly from two atmospheres' pressure to one, or from six to three; and the Admiralty regulations for safety from bubble-formation in diving are based on this fact. Hence a sudden diminution of pressure from normal to half an atmosphere would not be dangerous, even if the decompression were a prolonged one. The momentary diminution observed by M. Arnoux was, however, only 350 mm., or not quite half an atmosphere.

It appears, therefore, to be impossible to accept the bubble theory of the action of bursting shells in killing men without visible wounds or mechanical injury. The newspaper accounts of men being killed by bursting shells in some sudden and mysterious manner, without wounds or bruises, appear to be imaginary. The experience of those who have been exposed to shell fire does not, so far as the writer's inquiries go, lend any support to these accounts. Neither poisonous gases nor any other known cause would account for men being instantly killed without mechanical injuries. An air-wave of sufficient violence may doubtless knock men over and inflict mechanical injury capable of causing death; but the actual fatal injuries caused by shells appear to be almost all due to fragments of metal or of stone or other material set in motion by the explosion.

J. S. HALDANE.

DR. J. MEDLEY WOOD.

WE record with regret the death, on August 26, at the Botanic Gardens, Durban, in his eighty-seventh year, of the veteran director of the Natal Herbarium, Dr. John Medley Wood. Dr. Medley Wood was a native of Mansfield, Nottinghamshire, and had resided in Natal for sixty-three years.

Before his appointment as curator of the Natal Botanic Gardens in 1882 he practised for a time as a solicitor, and then went trading to Zululand, afterwards devoting himself to farming. His home was then at Inanda, where he spent some ten years, and besides undertaking experiments in the cultivation of arrowroot and castor oil he interested himself in the local flora, and contributed large and important collections of Natal plants to Sir Joseph Hooker for the National Herbarium at Kew. His activities in this latter direction were naturally stimulated on his appointment to the Gardens. Not only did he continue to enrich the collections at Kew, but he founded and gradually built up the very valuable Herbarium of Natal plants at Durban, which is a model of what a colonial herbarium should be.

When Dr. Medley Wood was appointed curator of the Natal Garden in February, 1882, by the Durban Botanic Society, the condition of the garden was by no means flourishing, but as funds allowed he was not long in restoring it to a condition of beauty and usefulness. The value of his work was so far appreciated that the Government grant towards the upkeep of the garden and the maintenance of the collections was gradually increased, and in 1902 the new building for the Herbarium was completed. In 1909 the Herbarium collection consisted of some 43,000 mounted and classified specimens. Medley Wood's publications on the Natal flora form valuable contributions to botanical science. In 1886 he published an analytical key to the orders and genera of Natal plants, but the most important of his works is that entitled "Natal Plants," of which six volumes have been published, the first part, consisting of fifty plates with descriptions, having appeared in 1898. Other useful publications include his "Handbook to the Flora of Natal" (1907) and a "Revised List of the Flora of Natal" (1908). His "Guide to the Trees and Shrubs in the Natal Garden," published in 1897, giving dates of planting, is a valuable record of

the work he did for the colony in the introduction of useful and interesting plants. He also did much for the improvement of the sugar-planting industry, and investigated many other problems of economic importance. In 1908 the Government grant for the garden and herbarium was much reduced, but although sadly hampered Medley Wood did not relinquish his efforts, and he was keenly interested in his work up to the end.

Dr. Medley Wood was appointed director of the Natal Garden, but he ceased to hold that office when it was recently handed over to the Corporation of Durban, and he then became director of the Natal Herbarium.

Two years ago the honorary degree of D.Sc. was conferred upon him by the University of the Cape of Good Hope, an honour which was a very fitting recognition of the great value of his services to botanical and agricultural science in South Africa, and gave much pleasure to his many friends.

NOTES.

We notice with much regret the announcement of the death, at ninety-two years of age, of M. J. H. Fabre, whose patient studies of the life-histories of insects, as recorded in his "Souvenirs Entomologiques" and other works, placed him in the front rank of outdoor naturalists throughout the world.

The Faraday Society will hold a general discussion on "The Transformations of Pure Iron" on Tuesday, October 19. The president, Sir Robert Hadfield, will preside over the discussion, which will be opened by Dr. A. E. Oxley, of Sheffield. Tickets may be obtained from the secretary of the Faraday Society, 82 Victoria Street, S.W.

We learn from *Science* that Dr. Max Planck, professor of physics at Berlin, and Prof. Hugo von Seeliger, director of the Munich Observatory, have been made knights of the Prussian Order of Merit. Dr. Ramón y Cajal, professor of histology at Madrid, and Dr. C. J. Kapteyn, professor of astronomy at Groningen, have been appointed foreign knights of the same Order.

The council of the Chemical Society has arranged for three lectures to be delivered at the ordinary scientific meetings during the coming session. The first of these lectures will be delivered on November 18, by Dr. E. J. Russell, who has chosen as his subject, "The Principles of Crop Production." The titles of the two later lectures to be delivered on February 3 and May 18, by Prof. W. H. Bragg and Prof. F. Gowland Hopkins, respectively, will be announced later.

The new session of the Royal Geographical Society will open on November 15 with a paper by the president, Mr. Douglas W. Freshfield, on the southern frontiers of Austria. Among other papers to be read at evening meetings are:—The work of the Peru-Bolivia Boundary Commission, Sir Thomas H. Holdich; The geographical and ethnic position of the Slavs between the Adriatic and the Drave, Sir Arthur Evans; Cyrenaica, Prof. J. W. Gregory; The Troad and the command of the Dardanelles, Dr. Walter Leaf; The valley of Mexico, A. P. Maudslay; and the Gold Coast, A. E. Kitson.

A Reuter message from Paris states that the French Minister of War has appointed a consulting committee of experts attached to the Under-Secretaryship of Military Aeronautics. Among other well-known names, the Committee, which is presided over by the Under-Secretary himself, includes M. Appell, who occupies one of the chairs of mechanics at the Sorbonne; M. Robert Esnault; M. Pelterie; M. Deslandres, director of the Meudon Obsrvatory; M. Deutsch, president of the Aero Club; M. Renault; M. Clement Bayard; M. Eiffel; and M. Kling, director of the Municipal Observatory.

We regret to notice that the *Engineer* for October 8 announces the death in action in France of Capt. W. McLeod Macmillan, of the 11th Argyll and Sutherland Highlanders. Capt. Macmillan was the chairman and managing director of the old-established shipbuilding firm of Archibald Macmillan and Son, Dumbarton, and was in his fortieth year. He was educated at Fettes College, Edinburgh, and succeeded his father in 1910. He acted for a period as chairman to the Clyde Shipbuilders' Association, and was a member of the council of the Institution of Engineers and Shipbuilders in Scotland.

At the recent International Congress of Mathematicians at Cambridge it was decided that the next congress should meet at Stockholm in 1916. The King of Sweden offered a gold medal with the likeness of Karl Weierstrass and a sum of 3000 crowns for an original important discovery in the domain of the theory of analytical functions. Competing manuscripts were to have been sent to the editor of *Acta Mathematica* before October 31 next, the centenary of the birth of Weierstrass. We are informed by Prof. Mittag-Leffler that in accordance with a widely expressed wish, the King of Sweden has decided, in view of the European war, to postpone the last day for the receipt of competing memoirs until October 31, 1916.

It is announced in the *Pioneer Mail* that the third annual meeting of the Indian Science Congress will be held in Allahabad from January 13–15, 1916, when Sir Sidney Burrard, F.R.S., will be president. The chief sections will be physics, chemistry, zoology, botany, agriculture, and ethnology, and the presidents of the respective sections Dr. Simpson, of the Meteorological Department; Dr. Sudborough, of the Research Institute, Bangalore; Dr. Woodland, of Allahabad; Dr. Howard, of Pusa; Mr. Coventry, of Pusa; and Mr. Burn. It is hoped that the local committee will persuade Dr. Bose to give a public lecture on his own researches. The local secretaries for this year are Dr. Hill, of Muir College, and Mr. P. S. Macmahon, of the Canning College, Lucknow, to the latter of whom all communications should be addressed. The congress is under the general control of the Asiatic Society of Bengal.

We announce with regret the death in action in Flanders on September 25 of Major A. J. N. Tre-

mearne, of the 8th Seaforth Highlanders. An Australian by birth, he served in the South African war, and later obtained an appointment in the Nigerian Police Force. There he acquired proficiency in the Hausa language, and studied the anthropology and folklore of this people. He then gained a scholarship at Christ's College, Cambridge, and was awarded the diploma in anthropology. The results of his work in Nigeria were published in "Hausa Superstitions and Customs," and "The Tailed Hunters of Nigeria." Later on he visited North Africa and published a work on demonology, entitled "The Ban of the Bori," in 1914. His sympathetic knowledge of the African races enabled him to carry out valuable field work, and the results of this were published in numerous papers in the Transactions of the British Association, the Royal Anthropological Institute, and the Folklore Society. It will be difficult to fill his place as a competent field anthropologist.

THE *Revue Scientifique* for September 18 reproduces an important address delivered at the Conservatoire des Arts et Métiers in February, by Prof. J. Violle. Its subject is the future of the physical industries of France after the war. By a comparison of the statistics of import and export of the countries of Europe he shows how France has in the last twenty or thirty years lost its place as a leading constructor of mechanical, electrical, and optical apparatus for the civilised world. He urges on the Government the importance of providing schools for the training of skilled workmen, of a National Laboratory of Weights and Measures on the lines of the National Physical Laboratory of this country, the Bureau of Standards of Washington, and the Physikalische Reichsanstalt of Germany. The country urgently needs such a central institution to which the scientific problems which arise in industry may be taken for solution. Behind these requirements he recognises the importance of following the example of Russia and removing the formidable temptation of alcohol from the workman's path, and points out finally how in the workshop, in the field, no less than in the army, France is suffering from "the shameful reduction in the birth rate."

THE abnormal condition of the market for feeding stuffs caused by the war suggested to Prof. Hendrick and Mr. W. J. Profeit the experiment described in Bulletin No. 20 issued by the North of Scotland College of Agriculture. The object of the experiment was to determine the feeding value of palm-kernel cake in comparison with linseed and decorticated cotton cakes. The first of these cakes is a feeding stuff hitherto little used in this country, almost the whole production going to the Continent, chiefly to Germany, where it has always found a ready market. Now, however, large stocks of palm-kernel cake are, or shortly will be, at the disposal of the home feeder. In Prof. Hendrick's experiment thirty head of cattle were divided into three lots, each consisting of six heifers and four bullocks. Throughout the period of eighty-four days covering the experiment, each lot of animals was fed with one variety of cake mixed with locust-bean meal in addition to a diet of swedes and straw to all alike. The three lots of cattle all did well, and the return in live weight increase was practically the same for each kind of cake. The monetary return from the palm-kernel cake was, however, considerably better than that given by either cotton or linseed cakes at present prices. Some doubts have been expressed as to the keeping properties of palm-kernel cake owing to the oil becoming rancid, but no difficulty of this kind was found after nine months' storage. The high percentage of fibre in this cake does not appear to affect the digestibility of the feeding stuff.

THE Board of Agriculture and Fisheries is circulating an appeal by Lord Selborne to the farmers and occupiers of land in England and Wales calling on them to produce as much food as possible during the coming year. No hope of financial support from the State is held out, but farmers are asked to do their part in increasing the supply of food as the special war service which they can render to their country. Leaving the precise means to be adopted to the farmer's judgment and to the advice of his friends and neighbours, it is suggested that the object in view may be attained by one or more of the following methods:—(*a*) By ploughing up the poorest permanent pasture and so increasing the arable land; (*b*) by shortening the period for which existing arable land is kept under clover or rotation grasses; (*c*) by improving the remaining grass land so that it will carry more stock; and (*d*) by reducing the acreage of bare fallow wherever possible. Lord Selborne realises the many special difficulties that have to be overcome, of which the chief is that of labour. Arrangements have already been made that men skilled in agricultural work, such as shepherds and engine-drivers, are not to be accepted for enlistment, yet this difficulty will remain with regard to the supply of ordinary farm labour. Machinery is to be set up to link the actual producer with the Board of Agriculture through the agency of local committees in each district, acting under the guidance of a War Agricultural Committee for each county. The farmer should consult his local committee on any problems or difficulties that may confront him. By this means it will be possible for the President of the Board to be kept informed of the needs of farmers throughout the country and to secure that all the help that can be given them is placed at their disposal.

THE idea of a universal permanent or durable peace has seemed to many minds merely Utopian. But the peculiar circumstances of a world-war are more and more forcibly impressing upon the world the desirability of realising the idea, and are also beginning to make clear the necessary bases of such realisation. The present war may be termed scientific from many aspects, and a permanent world-peace can only be attained by scientific study of the causes of war and of the possible ameliorating conditions. Several publications dealing with these matters have reached us recently. The Swiss thinker, Prof. August Forel, shows, in his "Die Vereinigten Staaten der Erde," how the causes of war and of this war are rooted in every department of social life and organisation. The *brochure* has many interesting *aperçus* on national psychology, and the meaning of race-hatred, war-

fever, and the like. It is worth translating into English for its scientific insight alone. In 1795 Immanuel Kant drew up a programme, "Zum Ewigen Frieden," which is still a classic. Messrs. George Allen have been well advised to issue this with translation in pamphlet form. The manifesto of the Central Organisation for a Durable Peace, at 51 Theresiastraat, the Hague, gives a minimum-programme for the bases of such peace, chiefly to invite suggestions and co-operation. It is the result of the international meeting held at the Hague last April. The *Comité Suisse pour l'étude des bases d'un traité de paix durable* have, on the lines of the Hague manifesto, issued a valuable *mémoire*, not individual, like M. Forel's, but impersonally legal. It contains references to articles of conventions and to recent literature on the general subject of permanent peace. Certainly there is now in process of creation a science of peace-maintenance, the successful results of which may regenerate both national and international life.

IN the issue of the Journal of the Royal Anthropological Institute for January–June, 1915, the president, Prof. A. Keith, publishes his presidential address on the Bronze age invaders of Britain. He fixes the date of this invasion about the year 2000 B.C., and he states that we are not yet in possession of sufficient evidence to determine how far this round-headed race replaced the older inhabitants of Britain. There were several parts of England, Wales, Scotland, and Ireland which they failed to penetrate; at least, we have not found in these parts their peculiar "round-barrow" graves. The problem is to ascertain the birthplace of this race. We find merely secondary settlements along the eastern shores of the North Sea and at the possible points of their embarkation. The hypothesis that they came from Asia may be discarded, as the belief is growing that our own continent may have produced its own races. The centre of dispersion was probably the central mountainous region of Europe. In Denmark we recognise two invading waves of round-heads, but the older or neolithic wave contained men marked by all the characters which we recognise in the English round-barrow people. They also settled in south Sweden, south-west Norway, at the mouths of the Elbe, Weser, and Ems, advanced down the Rhine valley, and reached the coast of Normandy. The paper deserves attention as an able summary of the results of modern research.

THE *Indian Journal of Medical Research* for July (vol. iii., No. 1) contains a number of valuable papers on subjects relating to tropical medicine. Major MacGilchrist discusses the relative therapeutic value in malaria of the cinchona alkaloids, and finds that hydroquinine is clinically superior to quinine and all the others.

THE report of the director-general of public health, New South Wales, for the year 1913, recently issued, contains a mass of statistical and other information relating to the public health of that colony. One of the most interesting sections deals with an outbreak of small-pox in Sydney, showing how mild and insidious this disease may sometimes be. It is also of interest because the disease was successfuly inoculated upon the calf.

THE third report of the Government Bureau of Microbiology, New South Wales, contains a number of valuable reports on the diseases of man, animals, and plants occurring in the colony, and on agricultural and economic problems. A diphtheroid bacillus was isolated from a number of surgical lesions in children. It was, however, not the true diphtheria bacillus; it conformed to one particular and distinctive type, which can be identified with comparative ease, and is named by Dr. Cleland the *Bacillus chirurgicalis*. The organism was usually non-virulent to guinea-pigs.

MANY biochemical reactions proceed in the manner of a mono-molecular reaction, as, for example, the killing of micro-organisms by heat and by disinfectants. T. Madsen and T. Watabiki show that the same holds good for the destruction of "complement" of blood-serum and of "hæmolytic amboceptors" by heat, the relation between the temperature, and the rapidity of reaction in both cases conforming in general to the law of van't Hoff and Arrhenius (*Bull. de l'Acad. Roy. des Sc. et des Lettres de Danemark*, 1915, No. 2).

"THE bird as a labourer," remarks a writer in the autumn number of *Bird Notes and News*, "is not recognised by the Board of Agriculture." This is indeed the case, because the Board has not yet risen to a full sense of its responsibilities. When it does it will establish a Bureau of Ornithology, such as has long been at work, both on the Continent and in the United States. In these countries the value of birds as destroyers of insect pests and of noxious weeds is fully recognised. The present number of our contemporary contains some valuable information on the subject of birds in relation to the farmer and gardener.

DR. J. M. DEWAR, in the *Zoologist* for September, continues his observations on "The Relation of the Oystercatcher to its Natural Environment." The present notes are concerned with the summer environment, and the nature of the nesting-sites and sources of food supply. The breeding-stations within the area examined fall into three distinct habitats—a hill-stream, a river-valley, and a beach habitat. But a strong similarity exists between all the stations of each habitat, variability of the factors being much less pronounced than in the winter environment. In such inland stations earthworms, tipulid, and coleopterous larvæ form the staple food of the young. In the lake-beach area a large sand-bank at the head of the loch, and a boulder area on its north shore, are used every year by the birds that have failed to breed, as places of assembly for bathing, sunning, and other activities. We should have been glad of some statement as to the number of birds breeding at these stations. But these details will perhaps be given in a later article, for the series is not yet completed.

MR. A. H. CLARKE, in the *American Naturalist* for September, discourses at length on asymmetry as developed in the genera and families of recent Crinoids. He maintains that the less favourable the

environment as a whole the greater becomes the proportion of asymmetrical forms. The two main factors in producing asymmetry are bathymetrical and thermal. This feature is least developed at the optimum temperature for crinoid life, and most developed in temperatures which are phylogenetically too warm or too cold. Excessive cold appears to be the determining factor in the asymmetry of the genus Promachocrinus; while the opposite condition, excessive warmth, similarly affects the family Comasteridæ. Internal unfavourable conditions, the author insists, have also to be taken into account, such, for example, as are induced by incipient phylogenetical degeneration through type-senescence, as in the Plicatocrinidæ, which, in recent seas, represent the almost exclusively Palæozoic Inadunata.

A FURTHER instalment of Mr. J. F. Duthie's "Flora of the Upper Gangetic Plain" has now been published. The present section, which forms part i. of vol. iii., deals with the families Nyctaginaceæ to Ceratophyllaceæ, and occupies 168 pages. The Euphorbiaceæ and Urticaceæ are among the most important of the families included, the former with twenty-one genera and the latter with seventeen. The genus Ficus, which has some 600 species, is represented in the Upper Gangetic plain by eighteen species, among which are such well-known trees as *Ficus bengalensis* and *F. religiosa*.

Monthly Weather Reviews are published with great regularity by the Government of India, and the issue for March, 1915, shows considerable activity on the part of the meteorological department. The review, which is drawn up under the superintendence of Dr. G. C. Simpson, is based on observations taken daily at 8 hrs. at 215 stations, and on additional observations taken at 10 hrs. and 16 hrs. at 14 stations. For the summary of rainfall, observations are used from about 2,300 stations. March was remarkably wet over by far the greater part of the Indian area, and with these conditions the air was damper and the sky more cloudy than usual in most parts of the country. The departures from normal temperature were generally feebly marked, whilst the barometric pressure in the plains was in excess of the normal. Observations are given of solar, magnetic, and seismic disturbances. Much detailed information can be obtained from the tabular results and from the illustrations contained in the review.

RAINFALL values for August, 1915, are given in *Symons's Meteorological Magazine* for September, and the results show very varied conditions for the month. Last August is so commonly quoted as being wet that it is somewhat surprising to find that the percentage of the average rainfall was 72 for England and Wales, 68 for Scotland, 83 for Ireland, and 75 for the British Isles as a whole. The London rainfall was 95 per cent. of the average, from the observations at Camden Square, but it may be remarked that the rainfall was much heavier at South Kensington, the recording station of the Meteorologcal Office, where the fall was about 50 per cent. above the normal. The values given for the several stations in different parts of the British Isles show very varying results. The greatest excess on the normal occurred at Shoeburyness, where the fall was 166 per cent. of the average, and this is at a station which is notably one of the driest in the whole kingdom. Scathwaite, which is normally the wettest portion of the kingdom, had only 37 per cent. of the average, which is as great a deficiency for August as any part of the country. The map giving the rainfall for the Thames Valley shows that the rains were extremely irregular and patchy, particularly in the neighbourhood of London.

A NOTE on the divide produced by a plate in a moving liquid is contributed by Mr. Tsuruichi Hayashi to the *Tôhoku Mathematical Journal*, viii., 1. The author arrives at the conclusion that "the divide is the locus of point (*sic*) from which two shortest equal normals can be drawn to the periphery of the plate immersed." But this result is based on an assumption for which justification is sought in quotations from Duchemin's results, taken from De Villamil's recent book on "Motion of Liquids," with explanatory additions in square brackets. From these extracts the Japanese writer bases his conclusions on the assumption that the lines of flow along the face of the plate are straight lines normal to the boundary. Unfortunately, however, this assumption appears to be based on a distorted quotation of Duchemin's actual statements, and the reference to "curved" diagonals in the case of a rectangular plate, which is attributed to Duchemin, would appear to "unjustify" (if such a word may be made) the interpretations which have led to the present writer's conclusions. It is easy to construct cases where the result would evidently not hold good, in particular in the case of figures with re-entrant angles, or again, figures composed of two or more separate areas.

AN important paper, which marks a real advance in the chemistry of the sulphites, has been contributed to the September issue of the Journal of the Chemical Society by Mr. C. S. Garrett from the University of Liverpool. It is shown that no power of selective absorption of light is possessed by the neutral sulphites, such as Na_2SO_3, or by the two types of alkyl sulphites, such as $C_2H_5.O.SO.O.C_2H_5$ and $C_2H_5.SO_2.O.C_2H_5$. Sulphurous acid in aqueous solutions, on the other hand, gives a very well-marked maximum of absorption at wave-length 2760. The important discovery is now announced that the acid sulphites, such as $NaHSO_3$, and the metabisulphites, such as $Na_2S_2O_5$, show no selective absorption in freshly prepared aqueous solutions, but develop this property after keeping for some weeks, especially if exposed to light. It is suggested that this alteration of properties is due to the chemical changes represented by the equations—

$$2NaHSO_3 \rightleftharpoons Na_2SO_3 + H_2SO_3$$
$$H_2O + Na_2S_2O_5 \rightleftharpoons Na_2SO_3 + H_2SO_3,$$

whereby the non-absorbent compounds on the L.H. of the equation are converted into a non-absorbent sulphite and an absorbent form of sulphurous acid. Incidentally, it follows that this absorbent compound must have a different structure from that of all its

derivatives; but as the gas gives an absorption-band at wave-length 2961, it is suggested that the absorbent compound is a hydrated form of sulphur dioxide formed according to the scheme—

$$(x-1)H_2O + H_2SO_3 \rightleftharpoons SO_2,xH_2O.$$

THE use of chains for power driving has increased greatly, and we note with interest from the *Engineer* for October 8 an account of a chain drive transmitting about 5000 horse-power in a hydro-electric plant on the Snake River in the State of Oregon. The chains connect the waterwheel shafts to the generator shaft, and the arrangement was designed to meet conditions imposed by financial considerations. These conditions necessitated the adaptation of generators designed for direct connection to waterwheels running at 225 revs. per minute under 50-ft. head, to the same wheels running at 160 revs. per minute under 20-ft. head. The generator is of 3600 kilowatts, three-phase, 60 cycles, and had to be operated at the intended speed. The problem was solved by changing the position of two waterwheel units, providing additional shafting, and driving the generator shaft from the two waterwheel shafts by driving chains and sprocket wheels. Each set of driving chains consists of four Morse silent chains, 22 in. wide, and transmits 2500 horse-power. This is believed to be the most powerful chain drive plant in the world, the nearest to it being that at Indianapolis, which drives a 1200 horse-power generator.

OUR ASTRONOMICAL COLUMN.

COMET 1915*d* (MELLISH).—A card from the Copenhagen Observatory informs us that the following elements and ephemeris have been calculated by Messrs. Braae and Fischer-Petersen for Mellish's comet from observations at the Yerkes Observatory on September 18 and the Lick Observatory on September 19 and 20:—

$$T = 1915 \text{ Oct. } 11{\cdot}933 \text{ M.T. Berlin.}$$

$$\left.\begin{aligned} \omega &= 108^\circ\ 33'{\cdot}16 \\ \Omega &= 72^\circ\ 50'{\cdot}17 \\ i &= 49^\circ\ 41'{\cdot}62 \end{aligned}\right\} 1915{\cdot}0$$

$$\log q = 9{\cdot}72054$$

M.T. Berlin.

	R.A. (true) h. m. s.	Dec. (true) ° ′
Oct. 14	13 38 38	+5 5·7
16	50 47	2 45·6
18	14 2 27	+0 25·7
20	13 39	−1 52·6
22	24 24	4 8·3
24	34 47	6 20·6
26	44 49	−8 29·0

A LARGE FIREBALL.—Mr. W. F. Denning writes:—"On the night of October 5 at 10h. 56m. Mrs. Fiammetta Wilson saw a large fireball from Portscatho, near Falmouth. It appeared in the N. by E. sky, its observed path being from 140°+68° to 126°+57°. A remarkable feature about the object was that it left a streak which remained visible for 17½ minutes, and underwent some curious transformations during the time it continued luminous. At first a straight band of glowing light, it gradually resolved itself into a large oval, which drifted slowly eastwards.

"The meteor must have been one of the most brilliant which has appeared for some time, and it is desirable to obtain further observations, both of the flight of the object and of the successive positions of the streak it left."

Mr. Arthur Mee sends us the following note upon the object:—

"A remarkable meteor was seen in south-west Wales on the evening of October 5. An observer at Mumbles says it appeared at seven minutes to eleven, and that the 'tail' retained its form for a minute and a half, and then gradually took the appearance of a hook, broadening as it did so, and finally fading away some seven minutes later. The meteor itself was so brilliant that it alarmed a dog and made it run indoors. An observer at Milford Haven says the appearance after the explosion of the meteor was that of a luminous cloud, 'a gigantic smoke-ring with wings.' It was first noticed in the zenith, and then gradually drifted in a north-easterly direction, becoming more diffuse, and finally disappearing soon after 11 o'clock. It was a bright, starry night, and the meteoric cloud was evidently self-luminous; the stars were seen quite clearly through it."

RECENT OBSERVATIONS OF VARIABLES.—One of four variable stars discovered by Dr. Silbernagel in 1907, since designated SS Aurigæ, belongs to the small class of long-period irregular variables of which U Geminorum is the best-known example. Almost from discovery it has received attention at Utrecht, where a large number of visual observations have been made by Prof. A. A. Nijland and Mr. van der Bilt (*Astr. Nach.*, 4814). Although most of the time it remains beyond visibility in the 10-in., twenty-five of its rather sudden accessions of lustre were followed during 1912–13. Of these, fourteen were "long" and eleven "short" maxima; correspondingly it was recorded brighter than 14·0m. for periods on the average of 14·6 and 8·2 days, attaining in the one case to 10·7m., in the other only reaching 11·0m. The mean curve for the "long" type of maximum almost precisely parallels that of U Geminorum, the latter being just one magnitude brighter. At Harvard the minimum brightness of SS Aurigæ has been measured as 15·9m., equivalent to 14·7m. in Prof. Nijland's system.

Mr. Torvald Köhl (*Astr. Nach.*, 4813) obtained further observations of 25, 1913, Ursæ Majoris during January–March of this year, from which the period of twenty-eight days gains additional weight.

A new variable star, 2, 1915, Cephei, has been found by M. Kostinsky, using the stereo-comparator (*Astr. Nach.*, 4809). The photographic magnitude increased by three units between November 29, 1911, and November 6, 1913, when it was 10·0m. M. Blazko has made confirmatory observations.

THE VICTORIAN OBSERVATORY.—The existence of this institution—better known as the Melbourne Observatory—is now definitely threatened. From Australian papers we learn that the State Astronomer, Mr. P. Baracchi, tendered his resignation last August after some thirty-nine years of Government service, the last fifteen years as successor to Mr Ellery. According to the *Age*, no successor is to be appointed, the State Government having decided to drop the work, thereby saving upwards of 4000*l.* annually. We trust some scheme of Commonwealth control will be evolved before it is too late.

THE PROPER MOTION OF A.G. WA. 5002.—In *Astr. Nach.*, No. 4814, Mr. R. J. Pocock, Nizamiah Observatory, Hyderabad, states that this star, No. 267 in Mr. van Maanen's recent list of proper-motion stars, has been photographed on two astrographic plates, neither of which shows any trace of proper motion.

FAMILY HISTORIES AND EUGENICS.

In the thirteenth bulletin (June, 1915) from the Eugenics Record Office (Cold Spring Harbour, Long Island, New York), Messrs. C. B. Davenport and H. H. Laughlin give precise directions for making "a eugenical family study." The general lines are similar to those of the records of family histories which Sir Francis Galton sought to initiate in Britain many years ago. Such a study, carefully made, is, the authors tell us, important to the individual, who may understand and guide himself better if he knows his hereditary assets and liabilities; important to society, which "can treat the delinquent individual more reasonably, more effectively, and more humanely, if it knows the 'past performance' of his germ-plasm"; important with a view to "vocational selection," the end of which is to get the right man in the right place; important for education, which should take some account of the inborn potentialities of the individual; and important, finally, in the selection of marriage-mates, or at least in avoiding obviously unfit unions.

The bulletin tells the inquirer how to construct his "family tree" when the facts have been secured, and how to make an "individual analysis." This rather formidable enterprise involves answering sixty questions as to life-history, and as to physical, mental, and temperamental traits. The framing of the questions embodies long experience, and even to put them to oneself is interesting. Drs. Hoch and Amsden supply an even more elaborate *questionnaire* as to mental and temperamental traits. It will be hard to discover any trait that this catechism leaves out. It begins by asking the victim "if his education is up to his opportunities," and it ends by asking in what he gets "his deepest satisfaction." The questions are much more penetrating than those of the census paper or the income-tax return, and some of them seem to demand for their truthful answer a rare degree of detachment. But the authors meet this objection by pointing out that the records are to be kept as confidential documents in the central bureau, and that one must not think too much of personal privacy when the welfare of the race is concerned. Certain it is that a scientific genealogy is worth working towards, and that this bulletin is a useful step in that direction—useful in educating public opinion and in giving critics something to work on. In this connection it may be doubted, for instance, whether it is a wise discretion to refrain from any attempt to differentiate in the recording of family data between heritable and non-heritable traits. It may also be asked whether there is not a distinct risk of developing a self-conscious pre-occupation about one's "traits"—that Herbert Spencer was always talking about—and a paralysing obsessional conviction of the fatalism of heredity, which is only one side of the case.

CHARACTER AND INTELLIGENCE.

The *British Journal of Psychology* has published as a monograph supplement (Cambridge University Press) the results of a research by Mr. Edward Webb on character and intelligence. The subjects of the inquiry were ninety-eight men students at a training college in 1912, ninety-six students at the same college in 1913, and four groups of schoolboys, amounting in all to 140. At the training college the prefects (second-year students), and at the schools the class-masters were utilised as judges, a pair of independent judges being employed in each case. Very careful instructions were given and detailed lists of qualities supplied. Examination results and experimental tests of intelligence were also used. All the assessments were ultimately translated into a scale of marks from +3 to −3. The "reliability coefficients" (correlations between the estimates of the same quality in the same individual by the two judges) were in many cases very low, the average being rather under 0·5, and nearly one-seventh of the qualities marked were rejected on the ground of unreliability. For those retained the average reliability coefficient is 0·55. The lowness of the "reliability coefficient" is held in part to be due to the care taken to secure independence between the estimates of the two judges. For intelligence-qualities the results are held to give a "strikingly thorough support" to the theory of a general factor. The deduced correlations of the general factor with the various estimates are discussed in detail, and give some interesting and unexpected results. Amongst the latter may be mentioned the fact that sense of humour, which has little correlation with the general factor, is fairly highly correlated with the estimates, the prefects' judgments being apparently biased by this quality. The character-qualities are discussed in the same way, and here again there is held to be evidence of a central factor, and this factor is in some close relation to "persistence of motives." This general factor markedly dominates all the correlations yielded by the estimates of moral qualities, the deeper social virtues, perseverance and persistence; also, negatively, qualities related to instability of the emotions and the lighter side of sociality.

SCIENCE IN THE WAR AND AFTER THE WAR.[1]

It is universally acknowledged that the outcome of the present war must be an entirely new chapter in human history and a point of fresh departure in social, economical, and intellectual life. Hence it is well to begin even now to take stock of our resources, to examine not only the reasons for our deficiencies but the directions of our reforms. Particularly are we concerned with the improved attitude which we shall have to take nationally with regard to all that study and knowledge which we call science and scientific research and invention. Hence an important matter is to consider the position of science in the war and after the war.

Scientific knowledge is the accumulation of exact information concerning the facts and laws of nature, and the scientific method is the process by which we gain it, viz., by experiment or observation and logical deduction therefrom.

The cardinal fact which lies at the basis of all this nature-study is that there is no finality in it. Its possibilities are infinite, and we can never touch bottom in all that there is to be known about the simplest objects or phenomena of nature.

Hence the very essence of scientific study is that the votary should himself make some advances. Merely to know what others have done or discovered may be necessary, but this alone does not make a scientific student. Accordingly the training required is that which imparts the power to make new knowledge, and the results must be judged by the degree to which it succeeds in so doing.

At this stage we may distinguish, however, two classes of workers. There are first those who are most interested in new facts or principles regardless of immediate utility, and, secondly, those who show ability in utilising this knowledge in so-called useful applications of science. The first class em-

[1] An introductory lecture delivered at University College, London, on October 6, by Prof. J. A. Fleming, F.R.S.

braces the purely scientific investigators, and the second the inventors.

The public is, unfortunately, apt to attach more importance to the inventions than to the investigations, regardless of the fact that there could be no applications if there were no knowledge to apply. This failure to recognise the value and unspeakable importance of a progressive disinterested study of nature is a characteristic British quality, and it is something very much more serious than a mere national trait or idiosyncrasy.

Philosophical students of politics have long recognised that all forms of government have their special defects, and democratic or representative Parliamentary government is no exception. One of the chief defects of the latter is that the men who gain the upper hand are too often the fluent or persuasive speakers or those who are skilled in managing public assemblies and masters in oratory and debate.

Hence, as Mr. F. S. Oliver points out in his very suggestive book, "Ordeal by Battle," in all countries where representative government prevails this type of leader exercises a considerable and predominant influence on public affairs. But with the professional speaker and politician an over-great importance attaches generally to phrases and to words. Success with them depends very much on how a thing is put, and the form of expression often overrules even the subject-matter itself. But the whole object of scientific work is the discovery of the truth, and not its obscuration. Therefore the ascertainment of fact or principle is in all this work of infinitely more value than the form of words in which it is expressed. Hence to the politician there is a certain uncongeniality about the scientific habit of mind, whilst the man of serious scientific training becomes at times impatient of the methods of the party politician, which have not facts at the back of them.

Accordingly the principal idea which it is necessary to instil into the public mind and drive home by every means is that our chief concern should be to bring the scientific method to bear upon all the affairs of the nation.

The second equally important truth is that the disinterested but systematic study of nature is of primary importance for national well-being. By disinterested study we mean pure scientific research not undertaken mainly for commercial reasons. Pope, I think, tells us that the proper study of mankind is man; but an even more important object of study for man is that of nature, and if we undertake that properly all other things in the way of applications will be added unto us. The point to notice, however, is that it is not everyone who possesses the necessary turn of mind for scientific investigation. There is a mysterious aptitude in some children for music, drawing, or other pursuits, and suitable training cultivates it. It is the same with the ability to discover or invent. Hence the primary duty of the nation with regard to its children is from the very earliest days to begin with them the study of nature, not in the repulsive form of learning things out of books, but by taking the child direct to the lap of Mother Nature and letting her teach the lessons about flowers, animals, stars, and earth structure.

All this, of course, means expenditure, but the nation has to learn this hard lesson, that education of the right kind cannot be given without wise and large outlay, and that there is nothing so expensive in the long run as cheap education. Another thing that has to be drilled into the public mind at all costs is that there are no short cuts to national efficiency or scientific pre-eminence.

The moment a deficiency is discovered, the tendency of the public is to cry out for some quick remedy; but quick remedies are very often quack remedies at best. We require, therefore, in the first place an entirely altered attitude of mind on the part of our public men, statesmen, and, above all, editors and managers of great daily newspapers towards scientific work, research, and teaching. We want a far greater appreciation of its supreme importance and of the attention that should be given to the cultivation of it under the guidance of expert leaders. The small degree to which genuine scientific work is appreciated, contrasted with mere sensational announcements not based on genuine discoveries or inventions, is seen in the treatment of scientific work by the daily Press, which, after all, only reflects the attitude of mind of the general public. Compare, for instance, the attention accorded before the war to politics, amusement, and fashion, and that accorded to accounts of scientific researches or lectures, in the principal daily papers. Worse still, some of them are apparently easily led to take up and boom perfectly unscientific but sensational announcements.

An illustration of this occurred not long ago in connection with a supposed great invention of a flying train. The scientific principle utilised was one discovered thirty years ago independently by Prof. Elihu Thomson and by me, and familiar for years to all electricians, viz. the repulsion exerted on electric conductors by a powerful alternating-current magnet. By this means the inventor proposed to raise a train off the rails and propel it, I think, at three hundred miles an hour. Every engineering student, however, knows well that the resistance to the motion of a train at high speed is largely air resistance, and that this increases very rapidly with the speed. Hence even if there were no rail or axle friction at all, an economical limit to the velocity is soon reached at which the cost of driving power becomes prohibitive.

The inventor ignored this important fact, and for a week at least the utmost nonsense was written in daily papers by journalists whose only qualification for the task was an exuberance of language and metaphor combined with an utter ignorance of scientific facts. New inventions or suggestions require careful, sympathetic, yet critical treatment, but the public are misled when imagination is allowed to run riot too soon. Nevertheless, even great discoveries or inventions, such as the Röntgen rays or wireless telegraphy, have been received with scepticism and their utility denied at first.

The daily Press, which has such immense influence on public opinion, should exercise wise guidance in these matters, aided by competent scientific opinion, yet with discrimination and care not to denounce novelty merely because it is new or strange.

Turning to the applications of science in the war, we can mention four chief departments of it under the headings: chemical, mechanical, electrical, and physical, which cover such appliances as high explosives, aeroplanes and dirigibles, submarines, wireless telegraphy, and range-finders. I shall not attempt to discuss the details of a fraction of all these applications, but just touch briefly on two departments which happen to have occupied my own attention during the vacation, viz. range-finders and wireless telegraphy from aeroplanes.

An extremely important matter in all war with projectiles is to ascertain the exact distance of the objective, whether it be ship or gun or building. The range of the projectile depends on the angle of elevation of the gun and the character of the ammunition and several other factors.

The proper setting of the gun can, of course, be determined by trial shots, but the larger the gun the more expensive this process, and the more necessary not to let the enemy know anything until a shot

or shell falls exactly where it can do most damage to him.

Range-finders have for their object to determine this distance by some optical appliance. They are divided into two classes: first, prism or base range-finders, and, secondly, subtend range-finders. We can explain the principle of these by reference to our eyes and the method by which we roughly judge the distance of an object. When we look at an object the optic axes of the eyes converge on it, and by long practice we are able to appreciate the inclination of the axes. The centres of the eyes are about 2½ in. apart. Hence we have a very short-based isosceles triangle, but we are enabled by our muscular sense to give a rough guess as to the angles at the base and practically to infer something about the length of the triangle. Again, we do it in another way by estimating the relative sizes of the image of known objects, such as a man or house or other thing which is formed on the retina. Another thing which assists us is the amount of detail we see in the object looked at.

The range-finders used in war are only more exact applications of the same principles. One of the most accurate is that of Profs. Barr and Stroud. This is a base or prism range-finder. It consists of a tube varying from half a metre to two metres, about 6 ft. in length. At the ends of this tube are two totally reflecting prisms, which receive rays from the object and send them down the tube. At each end of the tube is an object glass, which forms an image which is received on a peculiarly cut prism at the centre and by an eye-piece. The arrangement virtually forms a sort of double telescope corresponding to two eyes set 6 ft. apart. When the observer looks into the right eye-piece he sees a field of view which is divided into two parts, one produced by light coming into one object glass, and the other by that coming in at the other. If the object seen is a mast, say, of a ship, it appears broken in two parts. The observer can rectify or bring into agreement these two parts of the image by moving to or fro in the tube a thin prism. The position of this prism is read off on a scale seen with the left eye-piece. This scale shows the distance in yards of the object.

Thus on board our battleships a range-finder of this kind is placed in one of the fighting-tops on the masts, and the observer looking at a distant ship can in a few seconds move the prism, adjust the two parts of the image to agreement, and read off the range. He then sends down the range by telephone to the gun-layers. Thus in the battle of the Dogger Bank, and in that of the Falkland Islands, firing by our battleships began at about 17,000 or 18,000 yards. The range-finder would thus be continually sending down the ranges 20,000, 19,000, 18,000 yards, etc., and the gunners would keep the object vessel in sight and fire when the command was given as the known range of hitting was reached.

The same principle is applied in a smaller instrument for military use, called the Marindin range-finder, invented by Major Marindin, only in the latter instrument the means adopted for bringing the two parts of the field of view or image into agreement are by a movement of one of the prisms.

The Barr and Stroud range-finder is a very accurate instrument, and will determine ranges up to 20,000 yards, or about 12 miles, with an accuracy of 50 to 100 yards.

In the next place there are range-finders called subtend range-finders, which depend on the measurement of the size of an image of a known object. When we look at an object either with the eye or with a telescope at different distances, it appears to be smaller the farther away we are from it. In the case of the eye we have no means of measuring accurately this variation in size except by comparing the apparent size of the distant object with some near object the size of which is known. Hence judging distance by the eye requires long training, as all sportsmen, sailors, and travellers know.

Moreover, we are apt to be deceived as to the apparent size. Ask anyone, for instance: How large appears the full moon? Many people would say, As large as a shilling—meaning that it has the same apparent angular magnitude as a shilling seen at 10 ins. or 1 ft., which is the usual distance we hold a book or paper when reading.

But now, if you try the experiment, you will find that the full moon is covered by a very small pencil, like a pocket-book or dance-programme pencil, held at 10 in. from the eye. In scientific language, the apparent size of the moon is about half a degree, which means that it is covered by an object 1/10th in. in diameter held 1 ft. from the eye.

A man 6 ft. high would subtend the same angle at a distance of 720 ft. Hence you can tell the distance of a man by ascertaining the distance at which an object of known size, say a pencil, must be held so as just to cover his height. An ordinary pencil ¼ in. in diameter held horizontally at arm's length (=2 ft.) would just cover a man 5 ft. 8 in. high at a distance of 544 ft., or 181 yd. The subtend range-finder works on the principle of measuring the angular magnitude of the object. One way of doing this is to place in the focus of the eyepiece a plate of glass with divisions ruled on it with a diamond. If we know how many divisions are covered by an object of known height at a known distance, we can tell the distance of any other object of known height.

It is very seldom, however, that we do know the exact height of the object, and, moreover, it is very difficult to count up accurately many very small divisions ruled on glass when the object seen is at all dark.

During the vacation I have been turning attention to methods for overcoming some of these difficulties. As these inventions are being submitted to the Ministry of Munitions, I do not think it desirable to go into details as to the methods, but I will tell you the results. I have invented three forms of range-finder—one which is an improved subtend range-finder with which I can find the distance of any object the dimensions of which are known, whether height or width, or any part of it. Also I have invented methods for using two such instruments to measure the distance of objects the dimensions of which are not known. In the second place, I have invented a simple form of base range-finder which measures what is called in astronomy the parallax of any distant object, and hence determines its distance. In the third place, I have devised a simple form of depression or elevation angle meter by means of which the height of any hill, and also the distance of any object from it, or from an elevated position, can be determined by an observer standing at the top of the hill, provided that he can also see two marks placed at the base in line with the point of observation on the hill and at a known distance apart. These instruments are simple and inexpensive to construct, and give an accuracy of measurement quite sufficient to direct rifle or artillery fire or bomb throwing in trenches. One great advantage of my range-finder is that it can be used with a periscope from the bottom of a trench so that the observer need not be exposed at all, but can determine the distance of the enemy's trench by observation on any post of a wire entanglement or stick or rock or anything with a sharp outline. Another principle which may be applied in making a range-finder, which I have also done in my instruments, is to observe the variation in

the size of an object as seen in a small telescope by moving away from it a certain distance. Thus, suppose that a man was seen at a distance of 200 yd., or 600 ft., then his apparent height would be covered by the width of a pencil held about 2 ft. from the eye. Suppose the observer were to approach to half that distance or move in 300 ft., then the apparent size of the man would be doubled. If, however, the man were a mile away, then moving towards him 100 yd. would only increase his apparent height by about 6 per cent. Hence we can determine the distance of an object by finding out how much the apparent size is increased when we move in towards it 100 yd. or any assigned distance.

Another marvellous application of science in war is that of wireless telegraphy in connection with aeroplanes and airships as a means of scouting and rapid communication of intelligence.

The difficulties connected with it are, however, considerable, and it has greater limitations than the uninitiated would suppose.

In the case of aeroplanes the first of these is the weight of the apparatus. The military aeroplane is already loaded to its fullest extent. In addition to the pilot and observer and the bomb ammunition, it carries in nearly all cases some gun equipment. Hence any wireless apparatus must be made as light and compact as possible. A wireless transmitter of the so-called spark type involves three elements: (i) some source of electromotive force such as a battery or dynamo, (ii) an induction coil or transformer for creating a high electric potential or pressure, and (iii) some form of condenser or Leyden jar which is charged and then discharged across a spark gap, thus creating rapid movements of electricity called electric oscillations. These oscillations are then caused to create others in a long wire called the aerial wire.

In the case of aeroplanes and airships the source of electromotive force is generally a small dynamo or alternator, which is coupled to the engine, and the voltage or pressure is raised to 30,000 volts or so by a small transformer sealed up in oil in a box. The condenser consists of metal plates sandwiched between sheets of glass or ebonite, and the spark balls between which the spark passes are also enclosed. The weight of the whole apparatus has to be kept below 100 lb., and such apparatus has been designed having a weight of not more than 30 lb. The French use a set weighing about 70 lb. One of the difficulties is to dispose the aerial wire conveniently and safely. It is sometimes made of aluminium and stretched on insulators carried by light supports on the wings, but the difficulty is to obtain in this way sufficient length. One plan adopted is to coil the wire on a reel, which the observer can uncoil and let it float out behind the aeroplane.

The wire must be connected to the reel by a safety catch so as to be released at once if it catches in trees or buildings. By this means an aerial wire of 100 ft. in length can be employed. The observer has near his hand a key by which he controls the spark discharges and so sets up in the aerial wire groups of electric oscillations which create electric waves in the æther, and signal the message in Morse code.

In this manner there is not much difficulty in equipping aeroplanes with transmitters which will send messages 30 miles or so to a corresponding earth station.

These latter are the military portable motor-car or pack stations, the details of which were described in a lecture given here last year on "Wireless Telegraphy in War."

The receiving arrangements used on aeroplanes comprise a head-telephone which is worn by the observer associated with some simple form of detector such as a carborundum crystal, aided by which the observer hears the signals sent to him in Morse code as long and short sounds in the telephone.

The noise of the aeroplane engine and that of the rush of air renders this method of aural reception a matter of great difficulty, especially as the messages must be sent in secret code, and the observer must therefore hear every letter distinctly if the message is to be intelligible. Great efforts have been made to devise methods of reception which shall appeal to the eye by a visual signal rather than to the ear, but the exceedingly small electric currents set up in the aerial wire by the arriving waves make this a matter of extreme difficulty, and the problem has not yet been completely solved. There is then the difficulty caused by "jamming." If the signals from an aeroplane are picked up by a hostile station, this latter at once sends out powerful but unmeaning signals the object of which is to blur and drown out the reception or sending of signals by this aeroplane. Moreover, the sending of wireless signals by an aeroplane reveals its presence to hostile earth stations before it can be seen by the eye.

Hence wireless telegraphy may be a means of revealing the enemies' scouts, and it involves a certain kind of war in the æther as well as war in the air.

In the case of airships there are other difficulties as well, and it is interesting to note that there are special difficulties in connection with Zeppelins. These aerial monsters are, as everyone knows, constructed with a framework of aluminium, containing in its interior the eighteen or twenty balloons inflated with hydrogen. Now as we rise upwards in the air the electric potential increases rapidly, and if a conducting body at a height gives off water drops or products of combustion, it is rapidly brought to the potential of the air at the place where it is. In the case of Zeppelins this equalisation is no doubt brought about by the escape of products of combustion produced by the engines. When the conducting body is brought down suddenly to earth again, there may be a great difference of potential between it and the objects on the earth. If it is a good conductor, a spark may pass, and if it is, as in the case of a Zeppelin, a conducting body containing a highly inflammable gas, leakage of which cannot altogether be prevented, this spark may cause an explosion and destruction of the airship. Again, the violent electric oscillations created in all metal objects near powerful radiotelegraphic apparatus may cause sparks to jump between metal parts, and hence may inflame a hydrogen leak.

It has therefore been recognised that there are special electrical difficulties in connection with the working of wireless on rigid airships with metal frames and also in connection with the use of spark apparatus. However carefully the actual working spark is enclosed there is always risk of induced sparks.

There is room, therefore, yet for much research and experimenting in connection with the use of wireless telegraphy on aeroplanes and airships, and the practical problems are by no means completely solved.

This leads to the consideration of the methods we have adopted for dealing with these and all other suggestions of the same kind of the nature of war inventions.

The Royal Society appointed certain committees at an early stage in the war to deal with engineering or mechanical and with chemical inventions. These committees were constituted secret committees, and none of the fellows except the council and the small number of the appointed fellows were allowed even to know the names of the members. The ostensible reason for this unusual secrecy was that the committees should not be inundated with correspondence

from eager inventors and that their work was confidential, but this argument is scarcely valid because the names of the members of other inventions committees, such as those afterwards appointed by the Admiralty and the Ministry of Munitions, were made public. The publication of the names of members in no way necessitates the publication of information as to their work. In the formation of such committees the important qualification should be not merely scientific or theoretical learning, but sufficient practical knowledge of the matters considered.

The men whose opinions are valuable on war inventions are the men who have to use them, namely, experienced military and naval officers. Again, the value of an invention can usually only be estimated by a practical trial, and this means expenditure. It is an almost impossible matter to judge of an invention merely from a written description. An idea may be old or a method may be familiar, and yet it may be carried out in detail in such a manner as to have great practical value under certain conditions. The ability to form a correct judgment of an engineering invention requires a very wide experience, since it is not easy to appreciate the good points or anticipate the defects of an invention or suggestion or idea which has not been put to the test of practice. Nevertheless, the experts appointed by the Ministry of Munitions are doing valuable work in sifting out the useful ideas from the hundreds already submitted to them.

It is beyond any doubt that this war is a war of engineers and chemists quite as much as of soldiers.

The 42-cm. Krupp gun which smashed in a few days the fortifications of Liège, Namur, and Antwerp, which were confidently expected to hold out for months, is only a piece of heavy engineering. The complete gun weighs 87 tons, and the foundations or carriage 37 tons. Two hundred men are necessary to erect and work each gun, which requires twelve railway wagons for its transport and is composed of 172 parts. It takes twenty-five to twenty-six hours to erect in place. The projectile or shell weighs 8 cwt., and is 5′ 4″ long and 16½″ diameter. It is fired electrically from a distance of about a quarter of a mile, and each shot costs 550*l*. The range at which the Liège forts were destroyed was fourteen miles. The mere transport and erection of this gun, let alone its manufacture, demands engineering knowledge of a special kind. It is the same with smaller arms. The rifle, except as a support for a bayonet, has almost become obsolete in face of the machine gun.

To win this war we have to achieve engineering feats. The mammoth howitzer, the great armoured triple-engined aeroplane, and the quick-firing machine guns are all products of the engineer's workshop, and the pivot round which all Germany's maleficent power turns is Krupp's works at Essen, and the chemical and ammunition factories in Westphalia. The knock-out blow will be given at those points, and they must be reached through the air if trench work proves too slow.

But in addition to the concentration of engineering knowledge and skill on the problems of the war, we have to think as well of what will come after. What is required is not merely opinions on inventions already made, but the proper organisation of inventive power and scientific research to bring about new and useful results. This is only to be achieved by bringing to bear adequate combined inventive or scientific power on definite problems which are not too far removed from practical possibilities.

We have as yet made scarcely any progress in the creation of a disciplined army of scientific workers which shall embrace all the abilities in the Empire. We are still in the stage which by comparison with an army is that of a mob of civilians equipped for war with shot guns and sticks.

One reason for this, I think, is because our chief scientific body, the Royal Society, has not taken upon itself more the function of guiding and assisting the general direction of research and invention.

The real function of the Royal Society should be to organise, direct, influence, assist, and promote scientific research, and to do it by an efficient organisation embracing the whole of its fellows. It represents, or should represent, the very best ability in all departments of scientific knowledge, and it should be organised into grand committees of subjects, as suggested by Prof. Armstrong, on one or more of which every fellow should have his place. The work of these grand committees should be to guide and instigate research in their own departments, to organise general discussions on leading questions in the manner undertaken of late years by the British Association, and to help to direct towards common and important ends the powers of scientific investigation in our universities and colleges.

The special and technical societies provide the facilities required for the reading of papers. A paper on physics, chemistry, or engineering as a rule receives better discussion and criticism if read at the Physical, Chemical, or Engineering Societies than at the Royal Society, and the discussion on a paper, if proper time and notice are given, is often quite as valuable as the paper itself. Although the individualistic method of research in which each scientific worker takes up whatever kind of research he pleases has produced good results in the past and is in agreement with our national characteristics, it is a serious question whether we shall not have to put limits to it in the future. The problems which await solution require in many cases combined or co-operative research. One of the most useful improvements in the proceedings of our learned societies would be the devotion of more time to well-organised and predetermined subjects of debate with the object of advancing knowledge at the boundaries of cognate sciences.

This applies to the purely scientific problems, as well as to the problems of industrial research. It must be remembered that, after this war is over, in a military sense we shall immediately commence another war of a different kind, in which the weapons will not be bullets and shells, but our national powers of invention, scientific research, commercial organisation, manufacturing capabilities, and education, and these will be pitted against those of a highly organised Germany determined to win back in commerce by any and every means, fair or foul, that which has been lost in war.

That commercial and industrial war will be waged by our enemies with the same ruthlessness and neglect of all scruples as their military operations. We have said good-bye now and for ever to those easy-going amateur British methods which have held us in the past. What we require is to obtain a higher percentage efficiency in all our operations. We have to attain larger and better results in education, scientific research, and industrial work to increase our national output in every way.

We have been buying dyes, chemicals, optical instruments, and drugs from Germany, glass from Austria, arc light carbons, electric machinery, and a hundred other things we have no need to buy, and the reason is that we have been shirking the effort and research necessary to make them as cheaply or as well at home. But the England with a national debt of 2000–3000 millions sterling will be a different kind of place to live in from the England of the year before last, and we shall have to adapt ourselves to the new conditions by new methods of work.

One of the most important of these, I venture to think, is the extension of co-operative research, both scientific and industrial. In the case of industrial work manufacturers are afraid of making their wants and difficulties known lest the mere statement of them should enable a British rival to find a solution and get ahead. It is necessary to appreciate, however, that rivalry between British manufacturers is not nearly such a serious matter as the competition of Germany with all of them will become, and that British manufacturers will have to stand shoulder to shoulder to meet the common foe. German firms do not hesitate to pool their knowledge if it enables Germany to get ahead of other nations, and British trades will therefore have to meet this organisation by one of a similar kind. In the same manner I have long been convinced that far greater advances might be made in purely scientific research in many departments of knowledge if we were to adopt more extensively the custom of associated work. I mean by this the formation of committees of workers, not too large for expeditious decisions, but charged with the duty of investigating certain formulated problems. It is in this respect that our learned societies might do so much more than they do. The proceedings of these societies are mostly a record of isolated, disconnected pieces of work of very different scientific value. But if properly organised discussion were brought to bear on the question, it would be possible to induce investigators of reputation and ability to associate themselves more in conjoint work to the great advantage of our common knowledge. The learned societies should therefore fulfil to the adult and experienced investigator the same function which the professor or teacher should fulfil to his research students, viz., supply them with suggestions for lines of research to stimulate thought and invention.

It is quite certain that we shall have to organise in this way to a far higher degree than we have yet done what may be called the strategy of research, and that the learned societies should act in some capacity like the great general staff of an army towards the subordinate generals and corps commanders. We require therefore to get on to the councils of our learned and technical societies and into their presidential chairs not merely men eminent for their private researches, but men of large ideas with organising abilities and inspirational power. If we do not do this, then, although by a lavish sacrifice of life and treasure we may win, as we are determined to do, in the military and naval operations, we shall in the long run be hopelessly defeated in that slower but none the less deadly scientific and commercial competition which will follow upon the cessation of actual hostilities.

THE BRITISH ASSOCIATION.

SECTION D.

ZOOLOGY.

OPENING ADDRESS[1] BY PROF. E. A. MINCHIN, M.A., HON. PH.D., F.R.S., PRESIDENT OF THE SECTION.

The Evolution of the Cell.

I PROPOSE in this address to deal with an aspect of cytology which appears to me not to have received as yet the attention which it deserves, namely, the evolution of the cell and of its complex organisation as revealed by the investigation of cytologists. Up to the present time, the labours of professed cytologists have been directed almost entirely towards the study of the cell in its most perfect form as it occurs in the Metazoa and the higher plants. Many cytologists appear, indeed, to regard the cell, as they know it in the Metazoa and Metaphyta, as the beginning of all things, the primordial unit in the evolution of living beings. For my part I would as soon postulate the special creation of man as believe that the metazoan cell, with its elaborate organisation and its extraordinarily perfected method of nuclear division by karyokinesis, represents the starting-point of the evolution of life. So long, however, as the attention of cytologists is confined to the study of the cells building up the bodies of the higher animals and plants, they are not brought face to face with the stages of evolution of the cell, but are confronted only with the cell as a finished and perfected product of evolution, that is to say, with cells which, although they may show infinite variation in subordinate points of structure and activity, are nevertheless so fundamentally of one type that their plan of structure and mode of reproduction by division can be described in general terms once and for all in the first chapter of a biological text-book or in the opening lecture of a course of elementary biology.

One of the most striking features of the general trend of biological investigation during the last two decades has been the attention paid to the Protista, that vast assemblage of living beings invisible, with few exceptions, to the unassisted human vision, and in some cases minute beyond the range of the most powerful microscopes of to-day. The study of the Protista has yielded results of the utmost importance for general scientific knowledge and theory. The morphological characteristic of the Protista, speaking generally, is that the body of the individual does not attain to a higher degree of organisation than that of the single cell. The exploitation, if I may use the term, of the Protista, though still in its initial stages, has already shown that it is amongst these organisms that we have to seek for the forms which indicate the evolution of the cell, both those lines of descent which lead on to the cell as seen in the Metazoa and Metaphyta, as well as other lines leading in directions altogether divergent from the typical cell of the text-book. We find in the Protista every possible condition of structural differentiation and elaboration, from cells as highly organised as those of Metazoa, or even in some cases much more so, back to types of structure to which the term cell can only be applied by stretching its meaning to the breaking-point.

It is impossible any longer to regard the cell as seen in the Metazoa and as defined in the text-books as the starting-point of organic evolution. It must be recognised that this type of cell has a long history of evolution behind it, which must be traced out, so far as the data permit. The construction of phylogenies and evolutionary series is, of course, purely speculative, since these theories relate to events which have taken place in a remote past, and which can only be inferred dimly and vaguely from such fragments of wreckage as are to be found stranded on the sands of the time in which we live. All attempts, therefore, to trace the evolution of the Protista must be considered as purely tentative at present. If I venture upon any such attempt, it is to be regarded as indicating a firm belief on my part that the evolution of the cell has taken place amongst the Protista, and that its stages can be traced there, rather than as a dogmatic statement that the evolution has taken place in just the manner which seems to me most probable.

Before, however, I can proceed to deal with my main subject, it is absolutely necessary that I should define clearly the sense in which I propose to use certain terms, more especially the words "cell," "nucleus," "chromatin," "protoplasm," and "cyto-

[1] Abridged by the author.

plasm." Unless I do so, my position is certain to be misunderstood, as, indeed, it has been already by some of my critics.

The term cell was applied originally to the protoplasmic corpuscles building up the bodies of the Metazoa and Metaphyta, each such corpuscle consisting of a minute individualised mass of the living substance and containing a nucleus. Hence a complete cell is made up of two principal parts or regions, the nucleus and the remainder of the protoplasmic body, termed the cytoplasm. By some authors the term protoplasm is restricted to the cytoplasmic portion of the cell, and protoplasm is then contrasted with nucleus; but it is more convenient to consider the whole cell as composed of protoplasm divided into two regions, nucleus and cytoplasm.

We come now to the consideration of the body termed the nucleus, which undoubtedly possesses an importance in the life and functions of the cell far greater than would be inferred from the name given to it. I have described in general terms the typical nucleus of the text-books, as found commonly in the cells that build up the bodies of ordinary animals and plants. The minutiæ of the details of structure and arrangement of the constituent parts may vary infinitely, but the type remains fairly constant. When we come, however, to the nuclei of the Protista, such pronounced modifications and variations of the type are met with that a description in general terms is no longer possible. I will direct attention now only to one point. In the protist cell the chromatin is not necessarily confined to the nucleus, but may occur also as extranuclear grains and fragments, termed chromidia, scattered through the protoplasmic body; and the chromatin may be found only in the chromidial condition, a definite nucleus being temporarily or permanently absent.

The essential part of the nucleus is the chromatin, and the other structural constituents of the nucleus, namely, membrane, framework, and plastin or nucleolar bodies, are to be regarded as accessory components built up round, or added to, the primary nuclear material, the chromatin. Even with regard to the nuclei of Metazoa it is maintained by Vejdovsky that at each cell-generation the entire nucleus of the daughter-cell is produced from the chromosomes alone of the mother-cell. The simplest body which can be recognised as a nucleus, distinct from the chromidia scattered without order or arrangement throughout the protoplasmic body, is a mass of chromatin or a clump of chromatin-grains supported on a framework and lodged in a special vacuole in the cytoplasm.

This brings me to a point which I wish to emphasise most strongly, namely, that the conception of a true cell-nucleus is essentially a structural conception. A nucleus is not merely an aggregation of chromatin; it is not simply a central core of some chemical substance or material differing in nature from the remainder of the protoplasm. The concepts "nucleus" and "chromatin" differ as do those of "table" and "wood." Although chromatin is the one universal and necessary constituent entering into the composition of the cell-nucleus, a simple mass of chromatin is not a nucleus. A true nucleus is a cell-organ, of greater or less structural complexity, which has been elaborated progressively in the course of the evolution of the cell; it is as much an organ of the cell as the brain is an organ of the human body. As a definite cell-organ, it performs in the life and economy of the cell definite functions. As an organ of the cell, however, it has no homologue or analogue in the body of the multicellular animals or plants; there is no organ of the human body, taken as a whole, similar or comparable to the nucleus of the cell.

The foregoing brief consideration of the nucleus leads me now to discuss in more detail the nature and properties of the essential nuclear substance, the so-called chromatin. To define, or characterise adequately, this substance is a difficult task. The name chromatin is derived from the fact that this substance has a peculiar affinity for certain dyes or stains, so that when a cell is treated with the appropriate colouring reagents—with so-called nuclear stains—the chromatin in the nucleus stands out sharply, by reason of being coloured in a different manner from the rest of the cell. In consequence, the statement is frequently made, in a loose manner and without reflection, that chromatin is recognised by its staining reactions, but in reality this is far from being true. When a preparation of an ordinary cell is made by the methods of technique commonly in use, the chromatin is recognised and identified by its position in a definite body with characteristic structure and relations to the cell as a whole, namely, the nucleus, and this is equally true whether the chromatin has been stained or not. Any so-called chromatin-stain colours many bodies which may occur in a cell besides the chromatin, and it may be necessary to try a great many different stains before a combination is found which will differentiate a given cytoplasmic enclosure from a true chromatin-grain by its colour-reactions. The so-called volutin-grains, for example, which are found commonly in the cytoplasm of many protists, are identified by the fact that they have a stronger affinity for "chromatin-stains" than chromatin itself.

What, then, is the true criterion of the chromatin-substance of living organisms? From the chemical point of view the essential substance of the cell-nucleus would appear to be characterised by a complexity of molecular structure far exceeding that of any other proteins, as well as by certain definite peculiarities. Especially characteristic of chromatin is its richness in phosphorus-compounds, and it stands apart also from other cell-elements in its solvent reactions, for example, resistance to peptic digestion. How far these features are common, however, to all samples of chromatin in all types of living organisms universally, cannot, I think, be stated definitely at present; at any rate, it is not feasible for a cytologist of these days to identify a granule in a living organism or cell as chromatin solely by its chemical reactions, although it is quite possible that at some future time purely chemical tests will be decisive upon this point—a consummation devoutly to be wished.

The only criterion of chromatin that is convincing to the present-day biologist is the test of its behaviour, that is to say, its relations to the life, activity, and development of the organism. I may best express my meaning by an objective example. If I make a preparation of *Arcella vulgaris* by suitable methods, I see the two conspicuous nuclei and also a ring of granules lying in the cytoplasm, stained in the same manner as the chromatin of the nuclei. Are these extranuclear granules to be regarded also as chromatin? Yes, most decidedly, because many laborious and detailed investigations have shown that from this ring of granules in Arcella nuclei can arise, usually termed "secondary" nuclei for no other reason than that they arise *de novo* from the extranuclear chromatin and quite independently of the "primary" nuclei. The secondary nuclei are, however, true nuclei in every respect, as shown by their structure, behaviour, and relations to the life-history of the organism; they may fuse as nuclei of gametes (pronuclei) in the sexual act, and they become, with or without such fusion, the primary nuclei of future generations of Arcella; they then divide by karyokinesis, when the organism reproduces itself in the ordinary way by fission, and are replaced in their

turn by new secondary nuclei at certain crises in the life-history. In view of these facts, it can be asserted without hesitation that the ring of staining granules in Arcella is composed of, or at least contains, true chromatin-grains, extranuclear chromatin for which R. Hertwig's term chromidia is now used universally.

Having now defined or explained, as well as I am able, the terms of which I am about to make use, I return to my main theme, the cell and its evolution. To summarise the points already discussed, a typical cell is a mass of protoplasm differentiated into two principal parts or regions, the cytoplasm and the nucleus, or, it may be, two or more nuclei. The cytoplasm may or may not contain chromatin-grains in addition to other enclosures, and may possess cell-organs of various kinds. The nucleus, highly variable in minute structure, possesses one invariable constituent, the chromatin-material in the form of grains and masses of various sizes.

The cell, therefore, in its complete and typical form, is an organism of very considerable complexity of structure and multiplicity of parts. The truth of this proposition is sufficiently obvious even from simple inspection of the structural details revealed by the microscope in cells in the so-called "resting condition," but still more so from a study of their activities and functions. The vital processes exhibited by the cell indicate a complexity of organisation and a minuteness in the details of its mechanism which transcend our comprehension and baffle the human imagination, to the same extent as do the immensities of the stellar universe. If such language seems hyperbolic, it is but necessary to reflect on some of the established discoveries of cytology, such as the extraordinary degree of complication attained in the process of division of the nucleus by karyokinesis, or the bewildering series of events that take place in the nuclei of germ-cells in the processes of maturation and fertilisation. Such examples of cell-activity give us, as it were, a glimpse into the workshop of life and teach us that the subtlety and intricacy of the cell-microcosm can scarcely be exaggerated.

On the assumption that an organism so complex and potent was not created suddenly, perfect and complete as it stands, but arose, like all other organisms, by progressive evolution and elaboration of some simpler form and type of structure, it is legitimate to inquire which of the various parts of the cell are the older and more primitive and which are more recent acquisitions in the course of evolution. The evolution of the cell may be discussed as a morphological problem of the same order as that of the phylogeny of any other class or phylum of living beings, and by the same methods of inquiry.

The problem of cell-evolution may be attacked, beginning with the consideration of the primary structural differentiation of the typical cell, the distinction of nucleus, or rather chromatin, and cytoplasm.

Since no concrete foundation can be found for the view that cytoplasm and chromatin have a common origin in the evolution of living things, we are brought back to the view that one of them must have preceded the other in phylogeny.

For my part, I am unable to accept any theory of the evolution of the earliest forms of living beings which assumes the existence of forms of life composed entirely of cytoplasm without chromatin. All the results of modern investigations into the structure, physiology, and behaviour of cells, on the one hand, and of the various types of organisms grouped under the Protista, on the other hand—the combined results, that is to say, of cytology and protistology—appear to me to indicate that the chromatin-elements represent the primary and original living units or individuals, and that the cytoplasm represents a secondary product. I will summarise briefly the grounds that have led me to this conviction, and will attempt to justify the faith that I hold; but first I wish to discuss briefly certain preliminary considerations which seem to me of great importance in this connection.

It is common amongst biologists to speak of "living substance," this phrase being preceded by either the definite or the indefinite article—by either "the" or "a." If we pause to consider the meaning of the phrase, it is to be presumed that those who make use of it employ the term "substance" in the usual sense to denote a form of matter to which some specific chemical significance can be attached, which could conceivably be defined more or less strictly by a chemist, perhaps even reduced to a chemical formula of some type. But the addition of the adjective "living" negatives any such interpretation of the term "substance," since it is the fundamental and essential property of any living being that the material of which it is composed is in a state of continual molecular change and that its component substance or substances are inconstant in molecular constitution from moment to moment. When the body of a living organism has passed into a state of fixity of substance, it has ceased, temporarily or permanently, to behave as a living body; its fires are banked or extinguished. The phrase "living substance" savours, therefore, of a *contradictio in adjecto*; if it is "living" it cannot be a "substance," and if it is a "substance" it cannot be "living."

As a matter of fact, the biologist, when dealing with purely biological problems, knows nothing of a living substance or substances; he is confronted solely by living individuals, which constitute his primary conceptions, and the terms "life" and "living substance" are pure abstractions. Every living being presents itself to us as a sharply limited individual, distinct from other individuals and constituting what may be termed briefly a microcosmic unit, inasmuch as it is a unity which is far from being uniform in substance or homogeneous in composition, but which, on the contrary, is characterised by being made up of an almost infinite multiplicity of heterogeneous and mutually interacting parts. We recognise further that these living individuals possess invariably specific characteristics; two given living individuals may be so much alike that we regard them as of the same kind or "species," or they may differ so sharply that we are forced to distinguish between them specifically. Living beings are as much characterised by this peculiarity of specific individuality as by any other property or faculty which can be stated to be an attribute of life in general, and this is true equally of the simplest or the most complex organisms; at least we know of no form of life, however simple or minute, in which the combined features of individuality and specificity are not exhibited to the fullest extent.

The essential and distinctive characteristic of a living body of any kind whatsoever is that it exhibits while it lives permanence and continuity of individuality or personality, as manifested in specific behaviour, combined with incessant change and lability of substance; and further, that in reproducing its kind, it transmits its specific characteristics, with, however, that tendency to variability which permits of progressive adaptation and gradual evolutionary change. It is the distinctively vital property of specific individuality combined with "stuff-change" (if I may be allowed to paraphrase a Teutonic idiom) which marks the dividing line between biochemistry and biology. The former science deals with substances which can be separated from living bodies, and for the chemist specific properties are associated

with fixity of substance; but the material with which the biologist is occupied consists of innumerable living unit-individuals exhibiting specific characteristics without fixity of substance. There is no reason to suppose that the properties of a given chemical substance vary in the slightest degree in space or time; but variability and adaptability are characteristic features of all living beings. The biochemist renders inestimable services in elucidating the physico-chemical mechanisms of living organisms; but the problem of individuality and specific behaviour, as manifested by living things, is beyond the scope of his science, at least at present. Such problems are essentially of distinctively vital nature, and their treatment cannot be brought satisfactorily into relation at the present time with the physico-chemical interactions of the substances composing the living body. It may be that this is but a temporary limitation of human knowledge prevailing in a certain historical epoch, and that in the future the chemist will be able to correlate the individuality of living beings with their chemico-physical properties, and so explain to us how living beings first came into existence; how, that is to say, a combination of chemical substances, each owing its characteristic properties to a definite molecular composition, can produce a living individual in which specific peculiarities are associated with matter in a state of flux. But it is altogether outside the scope and aim of this address to discuss whether the boundary between biochemistry and biology can be bridged over, and if so, in what way. I merely wish to emphasise strongly that if a biologist wishes to deal with a purely biological problem, such as evolution or heredity, for example, in a concrete and objective manner, he must do so in terms of living specific individual units. It is for that reason that I shall speak, not of the chromatin-substance, but of chromatinic elements, particles or units, and I hope that I shall make clear the importance of this distinction.

To return now to our chromatin; I regard the chromatinic elements as being those constituents which are of primary importance in the life and evolution of living organisms mainly for the following reasons: the experimental evidence of the preponderating physiological *rôle* played by the nucleus in the life of the cell; the extraordinary individualisation of the chromatin-particles seen universally in living organisms, and manifested to a degree which raises the chromatinic units to the rank of living individuals exhibiting specific behaviour, rather than that of mere substances responsible for certain chemico-physical reactions in the life of the organism; and last, but by no means least, the permanence and, if I may use the term, the immortality of the chromatinic particles in the life-cycle of organisms generally. I will now deal with these points in order.

The results obtained by physiological experiments with regard to the functions of the nuclear and cytoplasmic constituents of the cell are now well known and are cited in all the text-books. It is not necessary, therefore, that I should discuss them in detail. I content myself with quoting a competent and impartial summary of the results obtained:—

"A fragment of a cell deprived of its nucleus may live for a considerable time and manifest the power of co-ordinated movements without perceptible impairment. Such a mass of protoplasm is, however, devoid of the powers of assimilation, growth, and repair, and sooner or later dies. In other words, those functions that involve destructive metabolism may continue for a time in the absence of the nucleus; those that involve constructive metabolism cease with its removal. There is, therefore, strong reason to believe that the nucleus plays an essential part in the constructive metabolism of the cell, and through this is especially concerned with the formative processes involved in growth and development. For these and many other reasons . . . the nucleus is generally regarded as a controlling centre of cell-activity, and hence a primary factor in growth, development, and the transmission of specific qualities from cell to cell, and so from one generation to another.[2]

I have mentioned already in my introductory remarks that the only trustworthy test of chromatin is its behaviour, and the whole of modern cytological investigation bears witness to the fact that the chromatinic particles exhibit the characteristic property of living things generally, namely, individualisation combined with specific behaviour. In every cell-generation in the bodies of ordinary animals and plants the chromatin-elements make their appearance in the form of a group of chromosomes, not only constant in number for each species, but often exhibiting such definite characteristics of size and form, that particular, individual chromosomes can be recognised and identified in each group throughout the whole life-cycle. Each chromosome is to be regarded as an aggregate composed of a series of minute chromatinic granules or chromioles, a point which I shall discuss further presently.

Even more remarkable than the relation of the chromosomes to cell-reproduction is their behaviour in relation to sexual phenomena. In the life-cycles of Metazoa the sexual act consists of the fusion of male and female pronuclei, each containing a definite and specific number of chromosomes, the same number usually, though not always, in each pronucleus. It has been established in many cases, and it is perhaps universally true, that in the act of fertilisation the male and female chromosomes remain perfectly distinct and separate in the synkaryon or nucleus formed by the union of the two pronuclei, and, moreover, that they continue to maintain and to propagate their distinct individuality in every subsequent cell-generation of the multicellular organism produced as a result of the sexual act. In this way, every cell of the body contains in its nucleus distinct chromatinic elements which are derived from both male and female parents and which maintain unimpaired their distinct and specific individuality through the entire life-cycle. This distinctness is apparent at least in the germ-cell-cycle of the organism, but may be obscured by secondary changes in the nuclei of the specialised tissue-cells.

Only in the very last stage of the life-cycle do the group of male and female chromosomes modify their behaviour in a most striking manner. In the final generation of oogonia or spermatogonia, from which arise the oocytes and spermatocytes which in their turn produce the gamete-cells, it is observed that the male and female chromosomes make a last appearance in their full number, and then fuse in pairs, so as to reduce the number of chromosomes to half that previously present.

As Vejdovsky has pointed out, there can be no more striking evidence of the specific individuality of the chromosomes than their fusion or copulation in relation to the sexual act. Is there any other constant element or constituent of living organisms exhibiting to anything like the same degree the essentially vital characteristics of individuality manifested in specific behaviour? If there is, it remains to be discovered.

I come now to the question of the permanence and immortality, in the biological sense of the word, of the chromatinic particles, which may be summarily stated as follows: the chromatinic particles are the only

[2] E. B. Wilson, "The Cell," second edition, 1911, pp. 30, 31.

constituents of the cell which maintain persistently and uninterruptedly their existence throughout the whole life-cycle of living organisms universally.

I hope I shall not be misunderstood when I enunciate this apparently sweeping and breathless generalisation. I am perfectly aware that in the life-cycle of any given species of organism there may be many cell-constituents besides the chromatin-particles that are propagated continuously through the whole life-cycle; but cell-elements which appear as constant parts of the organisation of the cell throughout the life-cycle in one type of organism may be wanting altogether in other types. With the exception of the chromatin-particles there is no cell-constituent that can be claimed to persist throughout the life-cycles of organisms universally. It may be that this is only the result of our incomplete knowledge at the present time. I am prepared, however, to challenge anyone to name or to discover any cell-constituent, other than the chromatinic particles, which are present throughout the life-cycle, not merely of some particular organism, but of organisms universally.

To recapitulate my argument in the briefest form; the chromatinic constituents of the cell contrast with all the other constituents in at least three points: physiological predominance, especially in constructive metabolism; specific individualisation; and permanence in the sense of potential biological immortality. Any of these three points, taken by itself, is sufficient to confer a peculiar distinction, to say the least, on the chromatin-bodies; but taken in combination they appear to me to furnish overwhelming evidence for regarding the chromatin-elements as the primary and essential constituents of living organisms, and as representing that part of a living body of any kind which can be followed by the imagination, in the reverse direction of the propagative series, back to the very starting-point of the evolution of living beings.

In the attempt to form an idea as to what the earliest type of living being was like, in the first place, and as to how the earliest steps in its evolution and differentiation came about, in the second place, we have to exercise the constructive faculty of the imagination guided by such few data as we possess. It is not to be expected, therefore, that agreement can be hoped for in such speculations; it would indeed be very undesirable, in the interests of science, that there should be no conflict of opinion in theories which, by their very nature, are beyond any possibility of direct verification at the present time. The views put forward by any man do but represent the visions conjured up by his imagination, based upon the slender foundation of his personal knowledge, more or less limited, or intuition, more or less fallacious, of an infinite world of natural phenomena. Consequently such views may be expected to diverge as widely as do temperaments. If, therefore, I venture upon such speculations, I do so with a sense of personal responsibility and as one wishing to stimulate discussion rather than to lay down dogma.

To me, therefore, the train of argument that I have set forth with regard to the nature of the chromatinic constituents of living organisms appears to lead to the conclusion that the earliest living beings were minute, possibly ultramicroscopic particles which were of the nature of chromatin. How far the application of the term chromatin to the hypothetical primordial form of life is justified from the point of view of substance, that is to say in a biochemical sense, must be left uncertain. In using the term chromatin I must be understood to do so in a strictly biological sense, meaning thereby that these earliest living things were biological units or individuals which were the ancestors, in a continuous propagative series, of the chromatinic grains and particles known to us at the present day as universally-occurring constituents of living organisms. Such a conception postulates no fixity of chemical nature; on the contrary, it implies that as substance the primitive chromatin was highly inconstant, infinitely variable, and capable of specific differentiation in many divergent directions.

For these hypothetical primitive organisms we may use Mereschkowsky's term biococci. They must have been free-living organisms capable of building up their living bodies by synthesis of simple chemical compounds. We have as yet no evidence of the existence of biococci at the present time as free-living organisms; the nearest approach to any such type of living being seems to be furnished by the organisms known collectively as Chlamydozoa, which up to the present have been found to occur only as pathogenic parasites. In view, however, of the minuteness and invisibility of these organisms, it is clear that they could attract attention only by the effects they produce in their environments. Consequently the human mind is most likely to become aware in the first instance of those forms which are the cause of disturbance in the human body. If free-living forms of biococci exist, as is very possible and even probable, it is evident that very delicate and accurate methods of investigation would be required to detect their presence.

If it be permissible to draw conclusions with regard to the nature of the hypothetical biococci from the somewhat dubious, but concrete, data furnished by the Chlamydozoa, the following tentative statements may be postulated concerning them. They were (or are) minute organisms, each a speck or globule of a substance similar in its reactions to chromatin. Their substance could be described as homogeneous with greater approach to accuracy than in the case of any other living organism, but it is clear that no living body that is carrying on constructive and destructive metabolism could remain for a moment perfectly homogeneous or constant in chemical composition. Their bodies were not limited by a rigid envelope or capsule. Reproduction was effected by binary fission, the body dividing into two with a dumbbell-shaped figure. Their mode of life was vegetative—that is to say, they reacted upon their environmental medium by means of ferments secreted by their own body-substance. The earliest forms must have possessed the power of building up their protein-molecules from the simplest inorganic compounds; but different types of biococci, characterised each by specific reactions and idiosyncrasies, must have become differentiated very rapidly in the process of evolution and adaptation to divergent conditions of life.

Consideration of the existing types and forms of living organisms shows that from the primitive biococcal type the evolution of living things must have diverged in at least two principal directions. Two new types of organisms arose, one of which continued to specialise further in the vegetative mode of life, in all its innumerable variations, characteristic of the biococci, while the other type developed an entirely new habit of life—namely, a predatory existence. I will consider these two types separately.

(1) In the vegetative type the first step was that the body became surrounded by a rigid envelope. Thus came into existence the bacterial type of organism, the simplest form of which would be a Micrococcus, a minute globule of chromatin surrounded by a firm envelope. From this familiar type an infinity of forms arise by processes of divergent evolution and adaptation. I will not attempt, however, to follow up the evolution of the bacterial type further, or to discuss what other types of living organisms may be affiliated with it, as I have no claims to an expert knowledge of these organisms.

(2) In the evolution from the biococcus of the pre-

datory type of organism, the data at our disposal appear to me to indicate very clearly the nature of the changes that took place, as well as the final result of these changes, but leave us in the dark with regard to some of the actual details of the process. The chief event was the formation, round the biococci, of an enveloping matrix of protoplasm for which the term periplasm (Lankester) is most suitable. The periplasm was an extension of the living substance which was distinct in its constitution and properties from the original chromatinic substance of the biococcus. The newly formed matrix was probably from the first a semi-fluid substance of alveolar structure and possessed two important capabilities as the result of its physical structure; it could perform streaming movements of various kinds, more especially amœboid movement; and it was able to form vacuoles internally. The final result of these changes was a new type of organism which, compared with the original biococci, was of considerable size, and consisted of a droplet of alveolar, amœboid periplasm in which were imbedded a number of biococci. Whether this periplasm made its first appearance around single individual biococci, or whether it was from the first associated with the formation of zooglœa-like colonies of biococci, must be left an open question.

Thus arose in the beginning the brand of Cain, the prototype of the animal—that is to say, a class of organism which was no longer able to build up its substance from inorganic materials in the former peaceful manner, but which nourished itself by capturing, devouring, and digesting other living organisms. The streaming movements of the periplasm enabled it to flow round and engulph other creatures; the vacuole-formation in the periplasm enabled it to digest and absorb the substance of its prey by the help of ferments secreted by the biococci. By means of these ferments the ingested organisms were killed and utilised as food, their substance being first broken down into simpler chemical constituents and then built up again into the protein-substances composing the body of the captor.

A stage of evolution is now reached which I propose to call the pseudo-moneral or cytodal stage, since the place of these organisms in the general evolution of life corresponds very nearly to Haeckel's conception of the Monera as a stage in the evolution of organisms, though not at all to his notions with regard to their composition and structure. The bodies of these organisms did not consist of a homogeneous albuminous "plasson," but of a periplasm corresponding to the cytoplasm of the cell, containing a number of biococci or chromatin-grains. In the life-cycles of Protozoa, especially of Rhizopods, it is not at all infrequent to find developmental phases which reproduce exactly the picture of the pseudo-moneral stage of evolution, phases in which the nucleus or nuclei have disappeared, having broken up into a number of chromatin-grains or chromidia scattered through the cytoplasm.

The next stage in evolution was the organisation of the chromatin-grains (biococci) into a definite cell-nucleus. This is a process which can be observed actually taking place in many Protozoa in which "secondary" nuclei arise from chromidia. With the formation of the nucleus the cytode or pseudo-moneral stage has become a true cell of the simplest type, for which I propose the term *protocyte*. It is now the starting-point of an infinite series of further complications and elaborations in many directions. With all the diverse modifications of the cell the nucleus remains comparatively uniform. It may, indeed, vary infinitely in details of structure, but in principle it remains a concentration or aggregation of numerous grains of chromatin supported on some sort of framework over which the grains are scattered or clumped in various ways, supplemented usually by plastin or nucleolar substance either as a cementing ground-substance or as discrete grains, and the whole marked off sharply from the surrounding cytoplasm, with or without a definite limiting membrane. There is, however, one point in which the nucleus exhibits a progressive evolution of the most important kind. I refer to the gradual elaboration and perfection of the reproductive mechanism, the process whereby, when the cell reproduces itself by fission, the chromatin-elements are distributed between the two daughter-cells.

The chromatin-constituents of the cell are regarded, on the view maintained here, as a number of minute granules, each representing a primitive independent living individual or biococcus. To each such granule must be attributed the fundamental properties of living organisms in general; in the first place metabolism, expressed in continual molecular change, in assimilation and in growth, with consequent reproduction; in the second place specific individuality. As the result of the first of these properties the chromatin-granules, often perhaps ultra-microscopic, may be larger or smaller at different times, and they multiply by dividing each into two daughter-granules. As a result of the second property, chromatin-granules in one and the same cell may exhibit qualitative differences and may diverge widely from one another in their reactions and effects on the vital activities of the cell. The chromatin-granules may be either in the form of scattered chromidia or lodged in a definite nucleus. When in the former condition, I have proposed the term chromidiosome for the ultimate chromatinic individual unit; on the other hand, the term chromiole is commonly in use for the minute chromatin-grains of the nucleus.

In the phase of evolution that I have termed the pseudomoneral or cytodal phase, in which the organism was a droplet of periplasm containing scattered biococci or chromidiosomes, metabolism would result in an increase in the size of the cytode-body as a whole, accompanied by multiplication of the chromidiosomes. Individualisation of the cytodes would tend to the acquisition of a specific size—that is to say, to a limitation of the growth—with the result that when certain maximum dimensions were attained the whole cytode would divide into two or more smaller masses amongst which the chromidiosomes would be partitioned.

In the next stage of evolution, the protocyte with a definite nucleus, it is highly probable that at each division of the cell-body, whether into two or more parts, the primitive method of division of the nucleus was that which I have termed elsewhere "chromidial fragmentation"; that is to say, the nucleus broke up and became resolved into a clump of chromidiosomes, which separated into daughter-clumps from which the daughter-nuclei were reconstituted. Instances of nuclear divisions by chromidial fragmentation are of common occurrence among the Protozoa, and represent probably the most primitive and direct mode of nuclear division.

It is clear, however, that if the chromatin-grains are to be credited with specific individuality and qualitative differences amongst themselves, this method of nuclear division presents grave imperfections and disadvantages, since even the quantitative partition of the chromatin is inexact, while the qualitative partition is entirely fortuitous.

It is not surprising, therefore, to find that the process of nuclear division undergoes a progressive elaboration of mechanism which has the result of ensuring that the twin sister-granules of chromatin produced by division of a single granule shall be

distributed between the two daughter-cells, so that for every chromatin-grain obtained by one daughter-cell an exact counterpart is obtained by the other; in other words, of ensuring an exact qualitative, as well as quantitative, partition of the chromatin-particles. In its perfect form this type of nuclear division is known as karyokinesis or mitosis, and all stages in its progressive development are to be found in the Protozoa.

In the evolution of nuclear division by karyokinesis two distinct processes are being developed and perfected in a parallel manner, but more or less independently; first, the method of the partition and distribution of the chromatin-grains between the two daughter-nuclei; secondly, the mechanism whereby the actual division of the nucleus and the separation of the two daughter-nuclei are effected in the cell-division. I have dealt elsewhere with the evolution of the mechanism of karyokinesis as exemplified by the numerous and varied types of the process found amongst the Protozoa, and I need not discuss the matter further here, but the behaviour of the chromatin-grains may be dealt with briefly. The main feature in the process of the exact quantitative and qualitative distribution of the daughter-chromatin between the daughter-nuclei is the aggregation of the chromatin-grains or chromioles into definite, highly individualised structures known as chromosomes. In the most perfected forms of the process of chromosome-formation the chromioles become united into a linear series termed by Vejdovsky a chromoneme, which is supported upon a non-chromatinic basis or axis.

The actual division of the chromatin takes place by the longitudinal splitting of the chromoneme—in other words, by simultaneous division into two of each of the chromioles of which the thread is composed. In this way every chromiole which was contained in the original chromoneme is represented by a daughter-chromiole in each of the two daughter-chromonemes. It follows that the familiar process of the splitting of the chromosomes in karyokinesis is a mechanism which brings about in the most simple, sure and direct manner an exact quantitative and qualitative partition of the chromatin-grains between the two daughter-nuclei.

The chromatin-cycle of a cell in which the process of division by karyokinesis takes place in its most perfectly developed form, may, therefore, be conceived as follows. The nucleus in its resting state contains a definite number of companies or brigades of chromatinic units (chromioles), each brigade spread over a certain extent of the nuclear framework forming a karyomere. As a preparation to division each separate brigade of chromioles falls into line as the chromoneme, forming with its supporting substance the chromosome; there are formed, therefore, just so many chromosomes as there were karyomeres in the nucleus. In this disciplined and orderly array each chromiole undergoes its division into two daughter-chromioles, so that each file or chromoneme of chromioles splits into two files. At the reconstitution of the daughter-nuclei each daughter-chromosome gives rise to a karyomere again, the chromioles falling out of the ranks and disposing themselves in an apparently irregular manner on the newly built framework of the daughter-nucleus to constitute their own particular karyomere. Thus karyokinesis differs only from the most primitive method of division by chromidial fragmentation in that what was originally a haphazard method of distribution has become a disciplined and orderly manœuvre, performed with the precision of the parade-ground, but in a space far less than that of a nutshell.

In the nuclear division of Protozoa, without going into detail, it may be stated broadly that all stages are to be found of the gradual evolution of the tactical problem which constitutes karyokinesis.

I have dealt briefly with the problem of the evolution of karyokinesis because the process of nuclear division is, in my opinion, of enormous importance in the general evolution of living organisms. I have expressed elsewhere the opinion that the very existence of multicellular organisms composed of definite tissues is impossible until the process of karyokinesis has been established and perfected. For tissue-formation it is essential that all the cells which build up any given tissue should be similar, practically to the point of identity, in their qualities; and if it is the chromatin-elements of the cell which determine its qualities and behaviour, then the exact qualitative division of the chromatin, as effected in karyokinesis, is indispensable as a preliminary to the production of identically similar daughter-cells by division of a parent-cell. Hence it becomes intelligible why, amongst Metazoa, we find the occurrence of nuclear division by karyokinesis in its most perfect form to be the rule, and "direct" division of the nucleus to be the rare exception, while, on the other hand, in the Protista, and especially in the Protozoa, we find every possible stage in the gradual evolution of the exact partition of the chromatin in the process of nuclear division, from chromidial fragmentation or the most typical amitosis up to processes of karyokinesis as perfect as those of the Metazoa.

I have confined myself to the evolution of the cell as this organism is seen in its typical form in the bodies of the multicellular organisms, starting from the simplest conceivable type of living being, so far as present knowledge enables us to conceive it. But there is not the slightest reason to suppose that the evolution of the Protista took place only in the direction of the typical cell of the cytologist. Besides the main current leading up to the typical cell, there were certainly other currents tending in other directions and leading to types of structure very unlike the cells composing the bodies of multicellular organisms.

In this address I have set forth my conceptions of the nature of the simplest forms of life and of the course taken by the earliest stages of evolution, striving all through to treat the problem from a strictly objective point of view, and avoiding as far as possible the purely speculative and metaphysical questions which beset like pitfalls the path of those who attack the problem of life and vitalism. I have, therefore, refrained as far as possible from discussing such indefinable abstractions as "living substance" or "life," phrases to which no clear meaning can be attached.

How far my personal ideas may correspond to objective truth I could not, of course, pretend to judge. If I might be permitted to attempt an impartial criticism of my own scheme, I think it might be claimed that the various forms and types of organisms in my evolutionary series, namely, the simple cell or protocyte, the cytode or pseudomoneral stage, the micrococcus, even the biococcus, are founded on concrete evidence, and can be regarded as types actually existent in the present or past. On the other hand, the *rôle* assigned by me to each type in the pageant of evolution is naturally open to dispute. For example, I agree with those who derive the bacteria as primitive, truly non-cellular organisms, directly from the biococcus through an ancestral form, and not at all with those who would regard the bacteria as degenerate or highly specialised cells. But the crux of my scheme is the homology postulated between the biococcus and the chromatinic particle

—chromidiosome or chromiole—of true cells. In support of this view, of which I am not the originator, I have set forth the reasons which have convinced me that the extraordinary powers and activities exhibited by the chromatin in ordinary cells are such as can only be explained on the hypothesis that the ultimate chromatinic units are to be regarded as independent living beings, as much so as the cells composing the bodies of multicellular organisms; and, so far as I am concerned, I must leave the matter to the judgment of my fellow-biologists.

I may point out, in conclusion, that general discussions of this kind may be useful in other ways than as attempts to discover truth or as a striving towards a verity which is indefinable and perhaps unattainable. Even if my scheme of evolution be but a midsummer night's fantasy, I claim for it that it co-ordinates a number of isolated and scattered phenomena into an orderly and, I think, intelligible sequence, and exhibits them in a relationship which at least enables the mind to obtain a perspective and comprehensive view of them. Rival theories will be more, or less, useful than mine, according as they succeed in correlating more, or fewer, of the accumulated data of experience. If in this address I succeed in arousing interest and reflection, and in stimulating inquiry and controversy, it will have fulfilled its purpose.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BIRMINGHAM.—A portrait of Prof. Lapworth (by Mr. B. Munns) has been presented to the University by Mr. W. Waters Butler.

Dr. Elgood Turner has been appointed demonstrator in anatomy for women students in succession to Dr. Violet Coghill, who has resigned.

Dr. Mary Clarke has been appointed lecturer in hygiene to the students of the Training College for Women.

Mr. B. Lloyd has been appointed demonstrator in anatomy for the session.

GLASGOW.—Prof. John Ferguson has resigned the Regius chair of chemistry, to which he was appointed in 1874. He had previously for nine and a half years been a junior teacher in the department. He has therefore been a member of the staff for more than fifty years. During his tenure of office the chemical laboratories of the University have been greatly enlarged, and separate departments of organic chemistry, metallurgical chemistry, and physical chemistry have been instituted under the charge of special lecturers. Among Prof. Ferguson's former pupils are many distinguished chemists, including Prof. Millar Thomson, Sir William Ramsay, Sir J. J. Dobbie, Carrick Anderson, Profs. Henderson, Boyd, Long, and Parker, and Dr. A. W. Stewart.

LEEDS.—The Vice-Chancellor has received the following message from the King:—"His Majesty feels that the assistance of the universities is a great asset to the cause for which we are fighting, as science plays such a prominent part in modern warfare."

LONDON.—A course in dynamical meteorology with practical work will be given at the Meteorological Office, South Kensington, on Fridays, at 3 p.m., during the second term by Sir Napier Shaw, director of the Meteorological Office and University reader in meteorology. The fortnightly meetings at the Meteorological Office for discussion of important contributions to current meteorology in colonial or foreign journals will be resumed at 5 p.m. on Monday, October 25, and will be continued on alternate Mondays until March 27, 1916, with the exception of December 20th and January 3. Students wishing to attend should communicate with the reader at the Meteorological Office. The lectures are addressed to advanced students of the University and to others interested in the subject. Admission free, by ticket, to be obtained on application at the Meteorological Office.

A COPY of the September issue of the *Reading University College Review* has been received. It contains a revised list of the names of present members of the staff, past and present students, and present servants of the college who are serving with his Majesty's Forces, or in the French Army. The college may well be proud of its roll of honour. Mr. W. E. G. Atkinson, who was formerly a lecturer of the Department of Agriculture, has been killed in action in the Dardanelles, and Mr. T. G. Malpas, demonstrator in the physics laboratory, has been wounded. The review also contains a list of recent original contributions to science by members of the staff.

THE various courses of instruction to be given at the North of Scotland College of Agriculture during the present session are set out in detail in the current calendar of the college. The courses are designed to prepare students for the degree of B.Sc. in agriculture in the University of Aberdeen, the university diploma in agriculture, the national diplomas in agriculture and dairying, the degree of B.Sc. in forestry, and the certificate in forestry granted by the Highland and Agricultural Society of Scotland. All courses are open to women as well as to men. With the aid of a grant from the Development Commission, a research department has been instituted. In accordance with the conditions under which the grant is received from the Commission, this department is managed by a joint committee representing the governors and the University Court. We notice the governors have acquired a college farm. Experiments and demonstrations will be carried out. Experimental plots, an experimental and demonstration garden, and a horticultural department, are in course of construction. It is also intended to carry on feeding and other experiments upon stock. The farm is conveniently situated about five miles from Aberdeen. It is proposed to institute a school of rural domestic economy for girls. There is a large mansion house on the college farm estate which will be equipped as a residence for the girls attending the school, and in which classes will be carried on.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, October 4.—M. Ed. Perrier in the chair.—J. **Boussinesq**: The correct calculation of the influence of climatic inequality on the velocity of increase of terrestrial temperatures with depth from the surface.—H. **Douvillé**: The orbitoids of the peninsula of California. A study of material arising from the geological explorations of Arnold Heim. Some specimens belong to the genus Orthophragmina, and it is the first time these have been discovered in this region. Some rare Foraminifera include specimens of *Amphistegina Niasi*.—E. E. **Barnard**: Some supposed movements in stars near the cluster Messier 11 = N.G.C. 6705. The observation of J. Comas Solá on movements of stars in the neighbourhood of this cluster do not appear to be well founded. They were based on the stereoscopic examination of photographs taken at an interval of three years. The author has examined photographs of the same

region separated by an interval of twenty-two years, making use of a Zeiss stereo-comparator, but no movement of the stars in question can be observed.—J. Comas **Solá**: The approximate positions of a small planet, apparently new.—C. **Camichel**: Hammering in water pipes entirely free from air. Experimental determinations of the velocity of wave transmission in an 80 mm. iron pipe, 154 metres long, and of the pressures produced by sudden closing of a tap in the main.—Alb. **Colson**: The heat disengaged by a solid body passing to the state of saturated or dilute solutions. Details of experimental studies by a new method on the heats of solution of common salt.—B. **Bogitch**: The reciprocal solubility of copper and lead. Copper and lead form a double layer when the amount of copper exceeds 34·5 per cent., and is below 87 per cent. This double layer can only exist between the temperature of solidification of the upper layer (940° C.) and 975° C.—Arnold **Heim**: The geology of the southern part of lower California.—MM. **Debierne** and **Regaud**: The use of the condensed radium emanation in closed tubes in the place of radium compounds, and the estimation (in millicuries of emanation destroyed) of the energy used up in radio-active applications in general. An account of the advantages, from the points of view of economy and ease of application, of condensed radium emanation for biological purposes.

NEW SOUTH WALES.

Linnean Society, August 25.—Mr. A. G. Hamilton, president, in the chair.—R. J. **Tillyard**: The physiology of the rectal gills in the larvæ of anisopterid dragonflies. The minute structure of the rectal gill was studied to find evidence for a solution of the difficult problem of the physiology of respiration in these organs. Seven separate elements are recognisable in the gills. The argument excludes four of these, leaving only three, viz., the cuticle, the epithelial syncytium of the gill, and its tracheal capillary loops, as the agents of respiration. These are suited for respiration by diffusion of gas from the rectal water-supply through the cuticle and syncytium into the capillaries. The old objection to this diffusion theory, viz., that it can be understood easily when once started, but that there is no explanation of how it could begin in the newly-hatched nymph, is disposed of by observations on the process of hatching, which prove that the tracheal gas is not derived in the first instance from the rectal water-supply, but from some unknown source in the anterior end of the larval body.—T. G. **Sloane**: Studies in Australian entomology. No. XVII.—New genera and species of Carabidæ. This instalment treats of the tribes Pamborini, Migadopini, Broscini, Cuneipectini, Nomiini, Pterostichini, Platynini, Oodini, Harpalini, and Lebiini. Four genera and thirty-two species are described as new; among the most noteworthy being—a new species of Pamborus, a new genus of the Antarctic tribe Migadopini, an additional species of the genus Cuneipectus (the type of a tribe confined to western Australia), and a species of Phorticosomus, which has the submentum bearing two horn-like processes, a character known only in the allied genus Dioctes from the Steppes east of the Caspian Sea.—O. B. **Lower**: Descriptions of new Australian Lepidoptera. Twenty-one species, referable to the Geometridæ, Monocteniadæ, Selidosemidæ, Limacodidæ, Ocneriadæ, Zeuzeridæ, Pyraustidæ, Œcophoridæ, and Xyloryctidæ, are described as new; with one exception, all are from Pinnaroo, South Australia, or from Broken Hill, N.S.W., or from both localities.

CAPE TOWN.

Royal Society of South Africa, August 18.—Dr. L. Péringuey, president, in the chair.—J. W. **Bews**: The growth forms of Natal plants. The author gives a detailed description of his work on the growth forms of Natal plants. The investigation of the growth forms of plants in relation to their environment is being recognised as a very important, if not the most important, branch of plant ecology. The study of the various plant communities and their determination by the environmental factors presents a more general aspect of the subject, and has hitherto perhaps on the whole received more attention from plant ecologists, though, of course, it includes a certain amount of the study of the separate growth forms. It is, however, in the more detailed study of the "epharmony" of the species of plants that a deeper insight is gained into the cause and effect relationship existing between the environment and plant life.—I. B. Pole **Evans**: The South African rust fungi. I. The species of Puccinia on Compositæ. Descriptions and accompanying notes are given of the species of Puccinia based mainly upon material which the author and his colleagues have collected during the past ten years in South Africa, and which is now represented in the Mycological Herbarium of the Union of South Africa at Pretoria. The material has been collected primarily with the object of elucidating the life-histories of the various rusts which are so destructive to many of our economic crops, and it is hoped that the descriptions of these parasites, of which this is the first instalment, may promote a more widespread interest in this group of plants, and may be the means of adding considerably to our present very imperfect knowledge of these fungi.—J. Steph. v. d. **Lingen**: Heating and cooling apparatus for Röntgen crystallographic work. The apparatus described has been devised by the author in order to facilitate the work of those who wish to carry on research on the determination of the energy of an atom at zero temperature and at very high temperatures. The energy of atoms and its relation to temperature is one of the many problems of modern physics. Since the publication of de Bye's extension of Laue's theory of Röntgen interference, several experiments have been performed with a view to determine, first, the validity of de Bye's theory, and, secondly, the variation of atomic energy due to "heat motion."

BOOKS RECEIVED.

Memoirs of the Geological Survey, England and Wales: The Coals of South Wales, with Special Reference to the Origin and Distribution of Anthracite. By Dr. A. Strahan and Dr. W. Pollard. Second edition. Pp. vi+91. (London: H.M.S.O.; E. Stanford, Ltd.) 2*s.*

Stars of the Southern Skies. By M. A. Orr (Mrs. J. Evershed). Pp. xii+92. (London: Longmans and Co.) 2*s.* net.

An Introduction to Applied Mechanics. By E. S. Andrews. Pp. ix+316. (Cambridge: At the University Press.) 4*s.* 6*d.* net.

Botany. By D. Thoday. Pp. xvi+474. (Cambridge: At the University Press.) 5*s.* 6*d.* net.

In Pastures Green. By P. McArthur. Pp. xi+364. (London: J. M. Dent and Sons, Ltd.) 5*s.* net.

Quantitative Laws in Biological Chemistry. By Dr. S. Arrhenius. Pp. xi+164. (London G. Bell and Sons, Ltd.) 6*s.* net.

Key to Geometry for Schools. By W. G. Borchardt and Rev. A. D. Perrott. Pp. 294. (London: G. Bell and Sons, Ltd.) 8*s.* 6*d.* net.

An Untamed Territory: The Northern Territory of Australia. By E. R. Masson. Pp. xii+181. (London: Macmillan and Co., Ltd.) 6*s.*

Leeds Astronomical Society. Journal and Trans-

actions for the Year 1914. Edited by C. T. Whitmell. Pp. 104. (Leeds: R. Jackson and Son; London: W. Wesley and Son.) 2s.

Principles of General Physiology. By Prof. W. M. Bayliss. Pp. xx+850. (London: Longmans and Co.) 21s. net.

Vicious Circles in Sociology, and their Treatment. By Dr. J. B. Hurry. Pp. 34. (London: J. and A. Churchill.) 2s. net.

The Rugby Course of Elementary Chemistry. By A. P. Highton. Pp. 79. (London: E. Arnold.) 2s. 6d.

Handy Logarithmic Tables. By Y. Uraguchi. (Tokyo: Y. Uraguchi.) 12 sen, or 3d.

On Certain Channels attributed to Overflow Streams from Ice-dammed Lakes. By Prof. T. G. Bonney. Pp. 44. (Cambridge: Bowes and Bowes.) 1s. net.

A First Course of Engineering Science. By P. J. Haler and A. H. Stuart. Pp. viii+191. (London: University Tutorial Press, Ltd.) 2s. 6d.

Experimental Physics. By Prof. H. A. Wilson. Pp. viii+405. (Cambridge: At the University Press.) 10s. net.

National Museum of Wales. Descriptive Handbook to the Relief Model of Wales. By W. E. Whitehouse. Pp. 62+plates vii. (Cardiff: The Museum.) 6d.

Mathematical Papers for Admission into the Royal Military Academy and the Royal Military College. February–June, 1915. Edited by R. M. Milne. Pp. 24. (London: Macmillan and Co., Ltd.) 1s. net.

Government of India. Department of Education. Indian Education in 1913–14. Pp. 75+plates. (Calcutta: Supt. Government Printing, India.) Rs. 1.8, or 2s. 3d.

Elementary Practical Metallurgy for Technical Students and Others. By J. H. Stansbie. Pp. viii+151. (London: J. and A. Churchill.) 3s. 6d. net.

The Alligator and its Allies. By Prof. A. M. Reese. Pp. xi+358. (New York and London: G. P. Putnam's Sons.) 10s. 6d. net.

Canada. Department of Mines. Geological Survey. Memoir 74: a List of Canadian Mineral Occurrences. By R. A. A. Johnston. Pp. 275. (Ottawa: Government Printing Bureau.)

Union of South Africa. Province of the Cape of Good Hope. Marine Biological Report, No. ii. for the year ending 30th June, 1914. Pp. 167. (Cape Town: *Cape Times*, Ltd.)

The Spirit of the Soil: or, an Account of Nitrogen Fixation in the Soil by Bacteria and of the Production of Auximones in Bacterized Peat. By G. D. Knox. Pp. xiii+242. (London: Constable and Co., Ltd.) 2s. 6d. net.

Some Frontiers of To-morrow. By Prof. L. W. Lyde. Pp. viii+120. (London: A. and C. Black, Ltd.) 2s. 6d.

A History of Babylon. By Prof. L. W. King. Pp. xxiii+340. (London: Chatto and Windus.) 18s. net.

Guide to the Australian Ethnological Collection exhibited in the National Museum of Victoria. By Dr. B. Spencer. Second edition. Pp. 128+28 plates. (Melbourne: D. W. Paterson and Co.)

Edinburgh Mathematical Tracts. No. 1: a Course in Descriptive Geometry and Photogrammetry for the Mathematical Laboratory. By E. L. Ince. Pp. viii+79. No. 2: A Course in Interpolation and Numerical Integration for the Mathematical Laboratory. By D. Gibb. Pp. viii+90. No. 3: Relativity. By Prof. A. W. Conway. Pp. 43. No. 4: a Course in Fourier's Analysis and Periodogram Analysis for the Mathematical Laboratory. By Dr. G. A. Carse and G. Shearer. Pp. viii+66. No. 5: a Course in the Solution of Spherical Triangles for the Mathematical Laboratory. By H. Bell. Pp. viii+66. No. 6: an Introduction to the Theory of Automorphic Functions. By L. R. Ford. Pp. viii+96. (London: G. Bell and Sons, Ltd.) 2s. 6d. net, 3s. 6d. net, 2s. net, 3s. 6d. net, 2s. 6d. net, 3s. 6d. respectively.

British Museum (Natural History). British Antarctic (*Terra Nova*) Expedition, 1910. Natural History Report. Zoology. Vol. iii. No. 1. Pycnogonida. By Dr. W. T. Calman. Pp. 73. (London: Longmans and Co., and others.) 5s.

DIARY OF SOCIETIES.

FRIDAY, OCTOBER 15.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—The Theory of Grinding, with reference to the Selection of Speeds in Plain and Internal Work: J. J. Guest.

TUESDAY, OCTOBER 19.

FARADAY SOCIETY, at 8.—The Transformations of Pure Iron. Discussion to be opened by Dr. A. E. Oxley.—*Papers*: The Transference of Electricity by Colloidal Particles: F. Powis.—(1) The Electrolysis of Nitric, Sulphuric, and Orthophosphoric Acids using a Gold Anode: (2) The Electrolysis of Concentrated Hydrochloric Acids using a Copper Anode: F. H. Jeffery.—The Thermal Decomposition of Hydrogen Peroxide in Aqueous Solution: W. Clayton.

INSTITUTION OF PETROLEUM TECHNOLOGISTS, at 8.—The Petroleum Industry of Mexico: P. C. A. Stewart.

WEDNESDAY, OCTOBER 20.

ENTOMOLOGICAL SOCIETY, at 8.

ROYAL MICROSCOPICAL SOCIETY, at 8.—A Statement upon the Theory and Phenomena of Purpose and Intelligence exhibited by the Protozoa, illustrated by Selection and Behaviour in the Foraminifera: E. Heron-Allen.

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THURSDAY, OCTOBER 21, 1915.

SCIENCE IN NATIONAL AFFAIRS.

WE printed last week a valuable address by Prof. J. A. Fleming on "Science in the War and after the War." Though the address was an introductory lecture at University College, London, and was open to the public without fee or ticket, only the briefest mention of it appeared in the periodical Press, and the points of national importance dealt with in it were unrecorded, except in our columns, in which it was our privilege to publish the address almost in full. We understand, of course, that the demands made upon the space available in the daily papers are many and insistent, yet we should have supposed that during the progress of a war in which victory will depend as much upon science and machinery as upon men, a summary of some of the points made by a leading authority upon applied science would be of greater public interest and importance than much of the unsubstantial chatter with which we are supplied daily.

In the course of his address, Prof. Fleming himself supplied a reason for the neglect of scientific aspects of national affairs, in comparison with the attention given to the superficial views of politicians and other publicists. While success in science is measured solely by discovery of facts or relationships, in politics and public life generally it is secured by fluent speech and facile pen. In scientific work attention must be concentrated upon material fact, but the politician and the writer attach greater importance to persuasive words and phrases, and by their oratory or literary style are able to exert an influence upon public affairs altogether out of proportion to their position as determined by true standards of national value. Power, as regards government of the affairs of the nation, does not come from knowledge, but from dialectics: it is the lawyer who rules, with mind obsessed by the virtues of precedent and expediency, and to him men of science and inventors are but hewers of wood and drawers of water.

Under a democratic constitution it is perhaps too much to expect that Parliament will pay much attention to scientific men or methods; yet, as was shown in the debate upon the scheme for the institution of an advisory council of scientific and industrial research last May, the members of the House of Commons are ready to support plans for bringing science in closer connection with industry. The monies provided by Parliament for this purpose are to be under the control of a committee of the Privy Council, which will be advised by a council constituted of scientific and industrial experts. The scheme was conceived rightly enough, but when it passed into the hands of officials of the Board of Education much of its early promise was lost. Most people would regard it as essential that the executive officers of a council concerned with the promotion of industrial research should know what is done in this direction in other countries, and have sufficient knowledge of science and industry to formulate profitable schemes of work. The success of such a body depends largely upon the initiative of the secretary; and in an active and effective council we should expect him to be selected because of close acquaintance with problems of industrial development along scientific lines. But what is the position in this case? The scheme is issued by the President of the Board of Education, Mr. Arthur Henderson, a Labour member, who owes his post entirely to political exigencies, the secretary to the committee of the Privy Council is the Secretary of the Board, Sir Amherst Selby-Bigge, whose amiability is above reproach, but who knows no more of practical science and technology than a schoolboy, and the secretary of the Advisory Council is Dr. H. F. Heath, whose interests are similarly in other fields than those of science.

The belief that the expert—whether scientific or industrial—has to be controlled or guided by permanent officials having no special knowledge of the particular subject in hand is typical of our executive system. While such a state of things exists, most of the advantages of enlisting men of science for national services must remain unfulfilled. The various scientific committees which have been appointed recently have, we believe, been able to give valuable aid in connection with problems submitted to them, but they would be far more effective if the chiefs of the departments with which they are associated possessed a practical knowledge of scientific work and methods. Without such experience the executive is at the mercy of every assertive paradoxer and cannot discriminate between impracticable devices and the judgment of science upon them. While, therefore, the country has at its disposal the work—either voluntary or nearly so—of experts in all branches of applied science, it cannot use these services to the best advantage unless the departments concerned with them have scientific men among the permanent officials; and that is not the case at present.

I

The unbusinesslike methods of Government departments have received severe criticism lately, but nothing has been said about the unscientific method of appointing committees of experts without well-qualified officers to direct or co-ordinate their work. The reason is that, with scarcely an exception, no daily paper has anyone on its staff possessing the most elementary knowledge of the meaning of scientific research. Our guides and counsellors, both on the political platform and in the periodical Press, can scarcely be expected to interest themselves greatly in subjects beyond their mental horizon, so when scientific matters are involved they confine themselves to a few platitudes, or say nothing at all. They are unable to distinguish a quack from a leading authority in science, and prefer to exercise their imaginations upon sensational announcements, rather than discuss the possibilities of sober scientific discovery. In all that relates to the interests of science—and that means in the end the interests of the nation—the men who influence public opinion and control the public Services are mostly unenlightened and therefore unsympathetic.

The tacit assumption that public committees or departments concerned with scientific problems must have at their head officers of the Army, Navy, or Civil Service is responsible for delay in taking advantage of available expert knowledge and for the neglect to make effective use of science in national affairs, whether in times of war or peace. Just as a member of the Government may serve in turn as president of the Board of Education, Board of Agriculture, Board of Trade, or any other department, without possessing any special qualifications to comprehend the work of either, so a public official may be placed in a position to dominate activities of which he cannot understand the significance. Some day we hope that this mad system will be swept away, and that the men who exert control in all Government offices will be those whose training or experience make them most capable of doing so effectively.

Neither the political nor the official mind in this country yet realises the power which science can give to the modern State; because classical and literary studies still form the chief high-road to preferment in Parliament or in public offices. From the elementary school to the university truly scientific work occupies but a very secondary position in comparison with the humanities. In these days the material advancement of a nation must depend upon the developments of science and technology; and care should be taken, therefore, to create interest in these subjects and foster attention to them throughout the curriculum or course of school and college. Many people no doubt believe that this is being done, but it is far from being the case, and the promise of a generation ago is likely to be unfulfilled while the power over expenditure upon practical education remains in the hands of men who have no sympathy with it. Men who are distinguished for their scientific work, or have had a practical training in science, are on the staff of the Board of Education, but they are all subordinate to officers whose interests are in other fields; and scientific education suffers accordingly. Thus it comes about that Mr. C. A. Buckmaster, late Assistant Secretary under the Board of Education, could say in an address to the Educational Science Section of the British Association last year:—

"There can be no doubt that there is less real systematic science teaching in our elementary schools than was the case twenty years ago, and that the proportion of the total expenditure on elementary education which can be looked upon as spent in promoting science instruction is decidedly less, not only in proportion, but in amount. . . . It is not too much to say that the weight of official recognition has passed from the scientific to the literary side of the secondary school, and that the time and energy devoted to instruction and practical work in science have shown a remarkable decrease."

Was there ever a more severe indictment of the literary official's inability to prepare the citizens of a modern State for the struggles before them than is contained in these conclusions as to the position of science in our schools? A quarter of a century ago scientific studies were gaining increased attention in the curriculum, and there was reason to hope that one generation would succeed another with greater ability to compete with other progressive peoples, and with increased distrust of political obscurantists and the pretensions of literary culture. We have not gained this power because the control of our educational system from bottom to top has been, and is, in the hands of men without knowledge of modern needs or of the essential difference between the study of words and of things. To the deadening influence of these official representatives of the humanities must be ascribed the deplorable fact that public interest in scientific matters or appreciation of the worth of scientific research is less intelligent, and relatively less extensive, than it was fifty years ago.

To the literary mind, a man of science is a

callous necromancer who has cut himself off from communion with his fellows, and has thereby lost the throbbing and compassionate heart of a full life; he is a Faust who has not yet made a bargain with Mephistopheles, and is therefore without human interest. Scientific and humanistic studies are, indeed, supposed to be antipathetic and to represent opposing qualities; so that it has become common to associate science with all that is cold and mechanistic in our being, and to believe that the development of the more spiritual parts of man's nature belongs essentially to other departments of intellectual activity.

"When scientific work is undertaken solely with the object of commercial gain, its correlative is selfishness; when it is confined to the path of narrow specialisation, it leads to arrogance; and when its purpose is materialistic domination, without regard to the nobler deeds of humanity, it is a social danger and may become an excuse for learned barbarity. But research is rarely inspired by these motives, nor does devotion to it necessarily inhibit interest in other notes with which a well-balanced mind should be in resonance. Direct contact with Nature and inquiry into her laws do, however, produce a habit of mind which cannot be acquired in literary fields, and they are associated with a wide outlook on life more often than is popularly supposed. Science is not only able to increase the comforts of life and add to material welfare, but also to inspire the highest ethical thought and action; and a prominent place should be given to it in all stages of educational work as much on account of its ennobling influence as because it is a creator of riches.

Success in science means the birth of new knowledge. Patient observation and productive thinking are what the world needs for progress, and what true scientific study demands. There are now so many opportunities of obtaining ready-made opinions that the habits of independent thought, caution in accepting assertion, and critical inquiry into evidence, are suffering atrophy by disuse. *Vox populi, vox Dei*, may be a sound democratic principle for political platforms, but it stands for nothing in science. The men who have advanced the human race throughout the ages are they who have stood for individuality as against the voice of the crowd. We need such leaders now, men who will guide the people instead of waiting for a mandate from them before embarking upon any enterprise; and we need, above all, that the chief officials of departments of State should have had a training in scientific methods before being entrusted with the control of national affairs. While indifference to these things is the distinguishing characteristic of our statesmen and administrative officers, it is useless to expect that the nation's business will be conducted efficiently or its scientific forces be organised on the large scale which modern conditions demand.

ANALYTICAL CONTROL OF MODERN DYES.

The Analysis of Dyestuffs and their Identification in Dyed and Coloured Materials, Lake Pigments, Foodstuffs, etc. By Prof. A. G. Green. Pp. ix + 144. (London: C. Griffin and Co., Ltd., 1915.) Price 8*s*. 6*d*. net.

MODERN developments in the manufacture of synthetic colouring matters have now rendered it possible for the dyer to obtain any desired shade of colour in many different ways, but the suitability of the colour to the conditions under which the dyed material is to be employed depends entirely on the blend of dyes selected. It is evident that some analytical control is desirable in order that the most favourable result can be guaranteed.

Largely owing to the labours, extending over many years, of the author and his collaborators, a method has now been devised which is sufficiently comprehensive and elastic to cope not only with all the known dyes, but also with mixtures of these substances.

The three introductory chapters of this work treat of the chemistry of colouring matters and of the classification of these materials according to their chemical and tinctorial properties. In regard to theories of the colour of organic dyes, Prof. Green seems still to be a faithful adherent of the "quinonoid" hypothesis, in spite of the fact that he has himself discovered at least one dyestuff, namely, primuline (p. 21), to which he has not ascribed a "quinonoid" chemical constitution. It should, however, be added that the practical scheme of analysis presented in this manual is based on the tinctorial properties of the dyes, and not on hypothetical views in regard to their chemical structure. An interesting table serves as the summary of these introductory chapters, in which the chief series of colouring matters are doubly classified in accordance with their chemical nature and their dyeing properties. This tabulation indicates in a striking manner the lines along which future research may lead to many still missing groups of dyes.

The analysis of the dyes in bulk leads to a division into four main classes, in which solubility in water, affinity for unmordanted cotton, and precipitation by tannin form the distinctive

properties. Further subdivision is effected by successive experiments on the reduction of the dyes and the oxidisability of their reduction products. Owing to recent intense activity in the manufacture of synthetic dyes, each subdivision nowadays contains apparently many members, but, on the other hand, many of the names under which dyes appear are only synonyms employed by different firms.

Although it is sometimes practically impossible to identify the specific dyes on any fabric, yet the author's scheme of analysis enables the analyst to refer these substances to their appropriate classes, after which complete identification may be achieved by comparative dye-tests with standard dyes of known constitution.

After a reference to the detection of artificial dyestuffs in articles of food, the scheme for identifying colouring matters on animal fibres is elaborated. The dyed fabric is subjected to "stripping tests," and also to the action of a reducing agent—in this instance, sodium formaldehyde-sulphoxylate (Rongalite). Separate tests are described for indigoid dyes and for mordants, and a few principles are laid down for the examination of woollen fabrics dyed with mixtures of dyes. In such cases, fractional reduction and "stripping" tests are useful, together with fractional separation by means of solvents.

The problem presented by dyed vegetable fibres is much more complicated than that arising from dyed wool. Many basic dyes, which, when applied to wool, are readily reduced by sodium hydrosulphite, are scarcely attacked by this reagent when they are fixed on tannin-mordanted cotton. Accordingly, the tannin mordant must first be removed by boiling the fabric with caustic soda solution saturated with sodium chloride, the latter compound being added to avoid stripping off the dye.

Certain azo-colours, especially the insoluble "ingrain" azo-derivatives formed on the fibre, offer considerable resistance to the reducing action of ordinary hydrosulphite, and are decolorised very slowly and imperfectly. To overcome this difficulty the reducing agent is rendered more active by the addition of a very small quantity of reducible compound or colouring matter. The most convenient catalyst or sensitiser for this purpose is anthraquinone, a small quantity of which is added to the sodium formaldehyde-sulphoxylate solution.

Indigo is still the premier blue dye, and on account of its high price and valuable tinctorial properties, the estimation of pure indigotin either in bulk or on the fibre is a matter of considerable commercial importance. Special attention may be directed to the method for estimating quantitatively the indigotin on animal fibres worked out by the author in collaboration with Gardner, Lloyd, and Frank, since this process affords an accurate means of detecting the great abuses obtaining in the prevalent practice of "topping" or "bottoming" indigo-dyed materials with other inferior colouring matters.

The identification of organic colouring matters, when carried out in the systematic manner advocated by the author, becomes an important branch of analytical chemistry, so that this handbook may be recommended not only to the makers and users of dyes, but also to all students of organic chemistry. The educational value of the treatise is well exemplified in the chapter on the determination of the constitution of azo-dyes, for the methods adopted would go far towards enabling the analyst to identify any one of the very large number of azo-colouring matters at present on the market.

An index of the principal colouring matters shows the position of these dyes in the analytical separations, which are arranged in twenty-six tables.

The present condition of military warfare existing between the principal industrial nations will, in all probability, be succeeded by a period of strenuous industrial competition between the belligerents. During this period the discoverers of new dyes will, for obvious reasons, no longer, as hitherto, endeavour to protect their discoveries by patents, but will rely rather on keeping secret the methods of manufacture and the chemical nature of the products. At this stage the analytical methods systematised by the author will acquire additional importance in their application to the investigation of new dyes of undisclosed constitution.

G. T. M.

RUDIMENTARY SCIENCE FOR COAL-MINERS.

An Introduction to Mining Science. A Theoretical and Practical Text-book for Mining Students. By J. B. Coppock and G. A. Lodge. Pp. x+230. (London: Longmans, Green and Co., 1915.) Price 2s. net.

THE object of this little book is to put before the young coal-miner a certain number of facts in elementary science, mainly chemistry and physics, in such a way as to impress them upon him more readily than can be done through the medium of ordinary text-books upon these sciences. Such subjects as combustion, flame, explosion, the atmosphere, mine gases, coal, etc., are treated, each in a short chapter, which commences with a few ele-

mentary scientific facts, generally illustrated by reference to phenomena which may fairly be expected to have come under the notice of an average youth, and by a few simple experiments, which the student is intended to repeat; the second part of each chapter indicates the application of the scientific facts thus inculcated to some portion of the miner's experience in the pit. Like all books that set out to teach only such portions of a science as find direct application in any particular branch of technology, this work deliberately sacrifices the educational value of science in order to arrive more rapidly and more easily at the results derived from the acquisition of scientific facts. It is undoubtedly a very good thing that a coal-miner should be thoroughly familiar with the fact that a combustible material intimately mixed with air forms an explosive mixture, but the acquisition of any number of such fragments of knowledge, however valuable in themselves, does not provide the mental training that is obtained by the systematic study of any branch of science. Such a book as the one under discussion should not therefore be regarded as an adequate substitute for scientific education, but at best as an introduction and an incentive to further and more regular study of the sciences involved. It is a book that may fairly be recommended to the higher classes of an elementary school in a coal-mining district, with the hope that it may give the lads a desire to pursue their scientific studies further in evening continuation schools, where they would take a regular course of easy chemistry or physics, or both.

The work upon the whole is well done; the main pitfalls in such a book lie in the direction of slipshod statements on the one hand and over-elaboration on the other. As an example of the former we may quote the statement on page 118 that hydrogen "is a colourless gas, violently explosive," and of the latter the attempt to teach the molecular structure of gases on page 2. The authors have, however, generally succeeded in steering their course fairly between either extreme, and the result is a book which should, as already said, be quite useful to beginners, and will leave them very little indeed to unlearn when they begin to advance further in their scientific studies.

MATHEMATICAL SCHOOL-BOOKS.

(1) *Arithmetic. Parts I., II., and III., complete with Answers.* By C. Godfrey and E. A. Price. Pp. xiii + 467. (Cambridge: At the University Press, 1915.) Price 4s.; without answers, 3s. 6d.

(2) *Pendlebury's New Concrete Arithmetic. Sixth Year.* By C. Pendlebury and H. Leather. Pp. 80. (London: G. Bell and Sons, Ltd.) Price 6d.

(3) *Plane Trigonometry.* By H. Leslie Reed. Pp. xiii + 290 + xvi. (London: G. Bell and Sons, Ltd., 1915.) Price 3s. 6d.

(4) *Statics. Part II.* By F. C. Fawdry. Pp. 159–305 + viii. (London: G. Bell and Sons, Ltd., 1915.) Price 2s.

(5) *Numerical Examples in Physics.* By H. S. Jones. Pp. xii + 332. (London: G. Bell and Sons, Ltd., 1915.) Price 3s. 6d.

(6) *Exercises in Laboratory Mathematics.* By A. W. Lucy. Pp. 245. (Oxford: At the Clarendon Press, 1915.) Price 3s. 6d.

THE ideal text-book of arithmetic still remains to be written, and the time has not yet come when the ideal book would be a financial success. It will equip the boy or girl with the knowledge of the subject necessary for his other studies and his after-life. It will drop some branches which have in the past had usefulness but are now useless, and it will refrain from dealing with problems the subject-matter of which is outside a boy's experience and unintelligible to him, even if the calculation involved is simple once the subject-matter is understood. The ideal book with our present imperial system of weights and measures will easily be comprised within a hundred pages, and when the imperial system is dropped and the metric system becomes general the length will be further reduced.

The discussion of prime factors, greatest common measure, and least common multiple leads up to the extraction of square and cube roots, the reduction of fractions to their lowest terms, the addition of fractions, and the simplification of complicated expressions. Now the final convenient form for any fraction (except the very simplest) is the decimal form, and instead of reducing a fraction to its lowest terms we turn it straight away into a decimal. For the addition of fractions, in place of the vulgar method with all the labour of common denominators, we convert each fraction to a decimal (to as many significant figures as we need), and then add. Complicated expressions rarely turn up in natural problems; they are in the main the invention of examiners and text-book writers. Very little time, therefore, need be spent upon prime factors, greatest common measure, and least common multiple, and these will occupy little space in the ideal text-book.

"Stocks and shares" should also be omitted. The arithmetic is of the simplest. The trouble is partly in the difficulty of the subject-matter, partly in the unfamiliarity of the subject-matter, and partly in the unsuitable nomenclature, so poor

in distinctions between face value and selling value, and so full of terms among which master and boys are equally at sea.

Some schools neglect arithmetic sadly, while others give it far more time than its real worth deserves. The latter group are responsible for the bulk of the present-day text-book, in their demand for endless examples. In these schools the correction of the overcrowded time-table will in time reduce the number of periods allotted to arithmetic, and the text-book will be reduced to a fraction of its present size.

(1) Meantime we have to make the best of present conditions, and Messrs. Godfrey and Price have produced a most usable arithmetic. While compelled to run to above four hundred pages and include all the customary items and tricks (except recurring decimals, for which omission we are thankful), they show in the preface how they would prefer to use the boy's time. Their explanations of difficult points are accurate, concise, and clear; see, for instance, their discussion of fractions. They have regard also to the recommendations of various open-minded and wise bodies, such as the Headmasters' Conference, the British Association Committee on type in school-books, and the Mathematical Association Committee. The book is to be highly recommended; it provides work for the most lavish use of time, and the wise master who limits the time for arithmetic has a wide choice in his selection of work.

There is much gain in clearness of type by the use of the solidus, for instance, in printing "19/20" to stand for nineteen-twentieths, but it is a pity to use the symbol to denote shillings in the same book.

In elementary schools, also, arithmetic is in a bad way. Not that the boys don't do it well. They do it only too well, and can tackle the most abstruse questions which, if done at all, ought to be done by algebra. Further, they can (or are expected to) tackle questions which are unintelligible to the plain, well-educated man; in these questions conventional meanings, used only in schools, are put upon phrases which are otherwise meaningless. That abomination, the recurring decimal, is firmly entrenched in the elementary school, and children are told to commit to memory the expressions as recurring decimals of all proper fractions with denominator 7. After such enormities it seems quite natural to find the children required to add together 6 days and 23 seconds, or 16 kilometres and 2 millimetres.

(2) In the "New Concrete Arithmetic" the authors are doing the best that is possible in the circumstances. The whole gamut of absurdities must be included if the book is to sell, and so long as the present excessive allowance of time is given to the subject it is difficult to provide a sufficient number of varied questions without degenerating at times into unsuitabilities. The idea of first presenting every rule in concrete form is good; it might be carried further, and require every question to be such as naturally arises in human life. It would be still better to require every question to be such as arises in the pupil's own environment, so that there might be a rural arithmetic for the country school and various kinds of industrial arithmetics for town schools. Before such arithmetics are possible, however, the time allotted to the subject must be severely cut down. For to restrict the book to natural human problems and such bookwork as is necessary for their treatment, means the excision of many whole sections.

Let us repeat that we impute no blame to Mr. Pendlebury and Mr. Leather, who do the best that circumstances allow. In everything the book is as good as others of the kind, and in beginning from the concrete it is miles ahead of the bulk of them.

(3) In trigonometry also the mathematical master—or the headmaster or somebody—sets apart too much time for the subject. The time has to be filled in, but how can it be done without "Identities"? Identities being fashionable must be included in any book that is to be a success on the market. Mr. Reed is not to blame; he cannot help himself. First let the time allowed in the school for mathematics as a whole, or for trigonometry, be cut down, and Mr. Reed will write you a good book. He will discard identities, and identities being gone he will discover that secants and cosecants and tangents have no use except for the specialist and for the making of identities, and he will drop them.

In the meantime Mr. Reed does what is possible. He begins the solution of triangles by formulas most of which result immediately from geometrical properties. In the only case that presents any difficulty, that in which three sides are given, the method of solution is due to Prof. Bryan; expressions are found for the sum and difference of the two portions into which a side is divided by a perpendicular from the opposite vertex.

The variety of the questions which are taken from human life deserves high praise; it is only by long-continued effort that they could have been collected.

We regret, however, to find results left in surd form, as on pages 140 and 141, with the remark that they "may be worked decimally." We should have expected Mr. Reed to set a good example by "working them decimally" himself.

(4) This book—"Statics," by F. C. Fawdry—can be confidently recommended. The problems dealt with come from house-building, bridge-building, engineering, and other human activities. We no longer meet the ridiculous and perfectly smooth elephant who balances himself on a perfectly rough cricket ball. The good and simple methods of the engineer, hitherto excluded from the school-book, now come to their own, and the book discusses within the limits of 150 pages the link polygon, Bow's notation, the bending of beams, brake horse-power, and three dimensional problems, and discusses them well. The only fault we have to find is that the author cannot spell *parallelepiped*.

(5) We scarcely know what to say about this book of Examples in Physics. It is most virtuous in drawing all its exercises from human life, or at least from the laboratory. There are none of the wicked old questions that prevailed when an irresistible projectile used to impinge on an immovable obstacle. But, after all, what shall it profit a man to work through all these virtuous questions and be unable to tell a galvanometer from a lens? The examples should surely go with work in the laboratory; and if a man works in a laboratory he finds his own data there, and does not want to have them supplied in a book.

(6) This is a good, honest, plodding book, providing all the intellectual apparatus we are entitled to get under the name of "Laboratory Mathematics," but scarcely with the clearness of statement and crispness of effect that the ideal book would have. The attempt to consider weight and mass separately is somewhat ambitious for a book of this range; until quite an advanced stage it is better for the student to be content with one of them. Again the term "specific density" is unfortunately like "density" to use for so different a meaning as the author gives it, and the distinction between "specific density" and "specific gravity" is too subtle for the ordinary mortal.

D. B. M.

OUR BOOKSHELF.

Amoebiasis and the Dysenteries. By Prof. L. P. Phillips. Pp. xi+147. (London: H. K. Lewis, 1915.) Price 6*s*. 6*d*. net.

DYSENTERY is a clinical term used to denote disease conditions running more or less the same course, but dependent upon various ætiological agents. The subject is one of great and growing importance, and the advance in our knowledge of it has of late been considerable, but the literature is much scattered. In the volume under review Dr. Phillips has summarised the whole subject, and has compiled a book which should be of considerable value and assistance to all those who have to deal with this disease.

The various forms of dysentery are discussed from the point of view of their causation, viz., amœbiasis or amœbic infection, ciliate and flagellate dysentery, bilharzial dysentery, and bacillary dysentery. Amœbic dysentery is caused by infection with an amœbiform protozoon, now known as the *Entamoeba histolytica*. A full description is given of this parasite and of its differentiation from other forms of amœbæ. There is so far as at present known only one organism causing amœbic dysentery, and this cannot be artificially cultivated, though several saprophytic forms seem to have been grown in the laboratory.

There is undoubtedly a form of dysentery due to infection by a ciliate organism, *Balantidium coli*, and the disease is probably not so rare as the published cases seem to show. Several flagellate protozoa are also under suspicion as causal agents in dysentery or dysenteric diarrhœa.

A very chronic form of dysentery is associated with bilharzial infection of the large intestine, particularly in Egypt; the parasite in this case is a worm. Lastly, there is the bacillary form of the disease, due to a bacillus of world-wide distribution, and apt to occur in epidemics, thus differing from amœbic dysentery.

Under each section, besides the description of the parasites, the symptoms and treatment are detailed so that this work forms a complete handbook on the subject of dysentery. A useful bibliography is appended.

R. T. H.

Alcoholometric Tables. By Sir Edward Thorpe. Pp. xiv+91. (London: Longmans, Green and Co., 1915.) Price 3*s*. 6*d*. net.

THE handy little book of alcohol tables prepared by the late Dr. Stevenson has been out of print now for several years, and a convenient volume, arranged on similar lines and brought up to date, has been a long-felt want. This is fully supplied by the tables under notice, which were compiled under Sir Edward Thorpe's directions at the Government Laboratory. They are based, as regards their main portion, upon the work of Blagden and Gilpin, Drinkwater, Mendeléeff, and the Kaiserliche Normal Eichungs Kommission. The first table shows the percentage of alcohol by weight and by volume, and the percentage of fiscal proof spirit, in aqueous solutions of ethyl alcohol of different specific gravities. The latter are given to four places of decimals, but for the even numbers only (*e.g.*, 0·9172, 0·9174, etc.). The one criticism suggested is whether it would not have been worth while to include the odd numbers as well. True, this would have made the book about half as large again, but it would have saved the user many small calculations.

The other tables serve for the comparison of the spirit values adopted for fiscal purposes in this country with those of the principal foreign countries. They show the indications of Sikes's hydrometer, with the corresponding percentages of British proof spirit, American proof spirit, and alcohol as evaluated on the French, German, and

Tralles systems. They give also the corresponding indications of the hydrometers used in Russia, Holland, Spain, and Switzerland.

All the tables are well arranged, well printed, and well spaced, with figures in large type: this all makes for accuracy and convenience in use.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Rule for Determining Direction of Processional Movement.

THE method of determining the sense of the precession is usually given in the following way:—"If the axis of angular momentum and the torque axis are drawn in the same sense (that is, for the same direction of turning), then the axis of angular momentum sets itself towards the torque axis."

By this method we must imagine the axis of rotation and torque, which cannot be seen directly. By the following method this is not necessary:—

"If you stand at one end of the axle of the gyroscope, it will precess in the same sense to the rotation of the wheel, as seen by yourself." Here, the moment of force due to your own weight determines the tilting couple. According to my experience, this is a very convenient and practical rule for the direction of precession of a gyroscope. W. WATANABE.

34 Waldegrave Park, Twickenham, September 28.

I AM obliged by your courtesy in allowing me to see Prof. Watanabe's communication. He sent me his rule some little time ago, but by an accident which I regret his letter did not receive immediate attention.

I take it that what Prof. Watanabe's very concise statement suggests is the following. Imagine the gyrostat, supported, let us say, at a point on its axis of symmetry, with that axis inclined at an angle θ to the upward vertical, and precessing under a couple produced by a gravity force applied at a point on the axis of symmetry. If that force be due to the weight of an observer standing on the axle and looking towards the spinning flywheel, the axle, with the observer, will be carried round in azimuth in the direction in which he sees the part of the wheel looked at carried by the rotation.

This is quite correct and convenient if it is the upper part of the wheel that is looked at, and if the precession is, as it is almost always taken to be, and usually is, that given by the numerically smaller root of the quadratic equation which determines the steady motion of the gyrostat for a given value of θ. But, except in the case of $\theta=90^\circ$, when the larger root is infinite, it is possible, by properly starting the gyrostat, to realise the precession given by the numerically larger root. This is the "adynamic" precession, so called because to a first rough approximation, this precession, if the gyrostat is rapidly rotating, is independent of the applied couple. In this case, when also θ is greater than 90°, and the roots are therefore opposite in sign, Prof. Watanabe's rule must be reversed. But it is to be noted also that, in these unusual circumstances, neither does the rule hold that the axis of spin follows the couple axis. A. GRAY.

The University, Glasgow, October 7.

The Meaning of "Chincough."

IN the notice (NATURE, October 7, p. 141) of the book, "A Chaplet of Herbs," the expression "chincough" is explained in parenthesis as "(hiccough)." The word is in everyday use in this country, and never in any other sense than the whooping-cough; its etymology being understood as connected with the French *chien* = a dog.

The popularly recognised cure for hiccup in children used to be, and may be still, to "frighten it away" by some sudden and discomposing question. It often proved to be quite efficacious. W. E. HART.

Kilderry, Londonderry, Ireland, October 10.

FELLOWSHIPS FOR INDUSTRIAL RESEARCH.[1]

THE subject of the pamphlet referred to below is one of first-rate importance, especially at the present time of crisis in certain branches of manufacture, the cause of which has been attributed to failure to link science and industry.

The experiment referred to is one devised by the late Prof. Duncan, of the University of Kansas (and later of Pittsburgh). It begins by insisting that technical training should not cut into the full graduate course in pure science. The failure to co-ordinate academic training with industrial methods is attributed to mistakes on both sides. It is urged on the side of industry that current industrial practice is always ahead of text-book presentation, that academic methods are too minute and cumbersome, and that whilst strict scientific accuracy is essential in a pre-graduate course, it must give place to less accurate time-saving processes in the factory.

The university professor is also accused of regarding the utilisation of science for human needs as more or less degrading to science itself, and that in consequence he is careless in selecting a chemist possessing the right qualifications; for as Dr. Duncan asserts, industrial research demands all the qualities which are necessary for success in pure science, together with ability to control workmen.

The case against industry is much more searching. Dr. Duncan considers that the failure on the part of the factory to appreciate the advantage of applied science is due to an incapacity to select chemists, inexperience in dealing with them, and ignorance of the facilities in the way of laboratories and libraries which should be placed at their disposal. He states that he has met with instances of chemists of high training, creative power, and practical character who are overburdened with routine drudgery and subjected to the interference of factory foremen, and are working under an entire misapprehension on the part of the officials of the company as to their possibilities and value. Moreover, it is pointed out that the manufacturer may not know the real nature of the problems which have to be solved, their relative importance, or the kind of knowledge required for their solution. He has no means of judging the qualifications of the men available for his researches

1 "An Experiment in Industrial Research." By T. L. Humberstone. Board of Education: Educational Pamphlets, No. 30. (London: Wyman and Sons, Ltd.) Price 4d.

or the expenditure on laboratories and equipment which the work would entail. He has had no experience of co-ordinating research work with the operations of the factory or of estimating the progress made. In short, though the pamphlet does not say so in so many words, the manufacturer is accused of ignorance of the scientific side of his industry.

Having thus presented the difficulties on both sides, Mr. Humberstone, the author of the report, proceeds to formulate Dr. Duncan's scheme of industrial research fellowships.

"Under this scheme a contract is entered into between the manufacturer and the university in which the object of the research is precisely defined. The contract provides that the fellow selected to conduct the investigation desired shall devote his whole time to the research with the exception of three hours a week, which he may devote to instructional work in the chemical department. The fellow is a member of the university, and pays all the regular fees with the exception of fees for laboratory and supplies, for which the instruction he gives in the university is accepted in lieu, unless in the opinion of the university his demands become excessive, in which case the manufacturer who provides the funds for the fellowship is expected to reimburse the university.

"In some instances the manufacturer makes a specific grant for expenditure on apparatus. The contract further provides that the fellow shall work under the direction of the professor of industrial chemistry, and shall forward to the manufacturer periodically through the professor reports on the progress of the work. The manufacturer agrees to pay to the university an annual sum for the emoluments of the fellow during the tenure of the fellowship, which ordinarily extends to two years."

A clause follows relating to the proprietorship of inventions made by the fellow, providing usually for a payment of ten or some other percentage of the net profits arising from discoveries, to be commuted at the desire of either party for a sum fixed by arbitration, and there are certain other details in regard to the publication and use of the discovery.

The advantages claimed under this scheme are that the university profits by the presence of men engaged in researches, which, though utilitarian in their object, may often throw light on questions of purely scientific interest. The university also secures the services of post-graduate students as instructors, and the influence of such a body of men who are keen on their particular work and enthusiastic as to the value of research, is an asset of considerable value. The manufacturer derives advantage from the resources of the well-equipped laboratories, museums, and libraries, and from the facilities offered to the fellow for consulting the staff of his own and other departments of the university when unforeseen difficulties present themselves, whilst at the same time the manufacturer is free from the responsibility of selecting the specialist (which is done by the university) or of supervising his researches.

The advantages of the scheme to the selected fellow are obvious. He is brought into direct contact with a manufacturer and a specific problem, and carries on his investigation under the advantage of being free from interference by foremen or managers. He has also opportunities of consulting a well-appointed library, of obtaining assistance from colleagues, and occasion to test his process under industrial conditions. Moreover, the researches may be put forward in his candidature for the doctorate of the university. The report concludes with an account of the practical working of the scheme, and the remarkable variety of problems which have been submitted to investigation.

The only point which the writer regards as open to serious criticism is that the industrial research of whatever character, whether connected with organic, inorganic, or physical chemistry or physics, is conducted in a special laboratory under the absolute jurisdiction of the director of the industrial research laboratories, instead of being carried out in that department which is specially concerned with the particular problem. Apart from this, the scheme appears to offer many advantages in the present condition of the scientific industries in this country, as well as in America. Whether it is an ideal scheme is another question. It is true that in Germany there are chemists working out in the university laboratories problems which have an industrial object, but the great bulk of such research is restricted to the splendidly equipped works laboratories. The reason for this is a simple one. The managers are trained men of science (as many are in this country) who know the methods of research and the value of the research chemist. They have no need of a director of industrial research. They are in a position to direct it themselves.

J. B. C.

CONSTRUCTIONAL DATA OF SMALL TELESCOPE OBJECTIVES.

THE National Physical Laboratory has recently published through Messrs. Harrison and Sons a pamphlet with the above title. This has been prepared at the request of the Director-General of Munition Supplies, and is primarily intended for the assistance of manufacturers of optical instruments who are engaged in the production of optical munitions. The glasses on which the calculations are based are in all cases taken from the most recent catalogue of optical glasses issued by Messrs. Chance Bros. and Co., of Birmingham (February, 1915). The comprehensive character of the tables may be gauged from the fact that all the dense flints of this catalogue are severally combined with all the crowns, two dense barium crowns of high refractive index alone being excepted.

Although the theoretical conditions which it is desired to satisfy in the case of these small objectives are identical with those which determine the construction of large telescope objectives, other considerations which are of little importance in the one case can by no means be neglected in the other, and it thus happens that the

objectives described in these tables are not given the forms determined by the astronomical telescope conditions—freedom from colour, central spherical aberration, and coma—but one of these is deliberately sacrificed to enable the crown and flint components to be cemented together. This leads to the consideration of six forms of objective, three of which have the crown lens before the flint and three with these lenses in the reverse order, two forms of each set of three being free from colour and from central spherical aberration, and one free from colour and from coma. Each of these forms is described in a separate group of tables.

With most of the glass combinations one of the forms with the crown lens placed before the flint has the two surfaces of the crown lens of nearly equal curvature, and a set of tables is included devoted to lenses in which these curvatures are exactly equal. Such lenses offer the very considerable advantage when rapid output and low cost is of importance, of requiring only two sets of tools for their production, one set corresponding to the equal curvatures of the crown lens and the surface of the flint lens which will be cemented to a face of the crown component, the other set being, of course, for the second surface of the flint lens.

To each group of tables giving the constructional details of its own particular type of lens is added a table showing the amount of the aberration—coma or spherical aberration, as the case may be—which has unavoidably been retained in consequence of the restraint imposed by the condition that the two components are to be cemented to one another. A glance at these tables shows which form of objective and what combinations of glasses are the most suitable to employ in various circumstances. The physical interpretation to be placed on these quantities is explained in a note which prefaces the tables. For convenience in reference all the tables relating to one form of objective are placed on a single opening of the pamphlet.

The fundamental tables relate to lenses in which the thicknesses are negligible. A second set of tables is added, showing the alterations in focal length produced by standard thicknesses, which are taken to be 1/40th of the focal length for the crown component and 1/80th of the focal length for the flint lens, and also the corrections to the curvatures which are necessary to give the thick lenses the same focal length as those of negligible thickness. For convenience in making such corrections the principal set of tables give the curvatures of each lens surface in addition to their radii of curvature. The foregoing particulars suffice to show that the pamphlet should not only be of immediate use to those for whom it has more especially been prepared, but should prove of permanent value to all who are engaged in the construction of small objectives. It may be obtained from the publishers, Messrs. Harrison and Sons, 45 St. Martin's Lane, London, W.C.; price 2*s*. 6*d*., plus postage.

The laboratory authorities state that it is hoped later to supplement this publication by a further paper dealing with the corrections which may be necessary for object glasses of somewhat larger size. They may also undertake further optical calculations needed to perfect instruments required by the naval and military authorities if it seems to them desirable.

T. SMITH.
R. W. CHESHIRE.

JEAN-HENRI FABRE.

IT is more than half a century since Darwin quoted Fabre in his "Origin of Species" and called him "that inimitable observer." Yet he has been with us and working till the other day—a resolute veteran, in spite of his extraordinarily hard and strenuous life, from which he wrung out the joys of discovery and devotion. In this sense he lived a successful life, and he had other rewards—the appreciative esteem of expert entomologists; the admiration of those who have enjoyed his intimate descriptions of the life and work of insects and his singularly vivid style; the encouragement of good friends, such as John Stuart Mill and Mistral; but one cannot escape the regret that, through imperfections in contemporary social organisation, his genius, which was marked by a unique blend of observing power and sympathetic insight, was through a large part of his life unduly distracted and inhibited by the cares of keeping up the supply of daily bread. Perhaps on his own side he carried the spirit of independence to an extreme. In any case there is a pathetic ring in his own words, a short time ago, about his life, that it "had not been exempt from many cares, nor very fruitful in incidents or great vicissitudes, since it had been passed very largely, especially during the last thirty years, in the most absolute retirement and the completest silence." The ten volumes of the "Souvenirs Entomologiques," many of the best chapters of which have been translated into English, remain as Fabre's lasting monument. They show us an observer of insects, second only to Réaumur, who was able, in a way all his own, "instinct pursuing instinct," as has been well said, to get at the insect's point of view.

After a somewhat disappointing early struggle as a professor at Ajaccio and Avignon, Fabre recoiled from conventionalities and settled down on a little desert corner near Orange, in the lower Rhone, and subsequently at Sérignan, and gave himself up to entomology. His studies were occasionally anatomical and physiological, and he watched many life-histories; but he was pre-eminently the student of animal behaviour. His work is marked by strong vitalistic convictions, organism to him transcending all mechanism; by a belief in instinct as a big underivable fact, quite different from intelligence; and by a strong prejudice against Darwinism, even against evolutionism. "The facts that I observe," he said, "are of such a kind that they force me to dissent from Darwin's

theories." It is not evident that he studied these theories, or those that have developed from them, with the open mind and carefulness with which he approached his insects in the Orange wilderness, but he felt that they were all too mechanical, and perhaps he was not far wrong. He did not, however, criticise constructively, or take account, so far as we know, of evolutionist yet not Darwinian positions, such as that of Samuel Butler, with whom he would have found himself, in his recoil from the mechanistic, in hearty sympathy.

While Fabre's aloofness from evolutionist interpretation must be regarded as a defect in his scientific work, there is surely truth in what has been said, that "in his sense of the dignity of facts; in his high standard of precision; in his appreciation of the trivial, Fabre came, in spite of himself, into fellowship with Darwin." Perhaps he occasionally read too much of the man into the insect—and he was himself as much a man of feeling as a man of science—but he made a big contribution to the interpretation of animate nature by his convincing evidence of its pervasive mentality and purposiveness. Fabre was a Chevalier of the Legion of Honour and a corresponding member of the Institute.

NOTES.

As an outcome of the recent Manchester meeting, the British Association has invited the following gentlement to serve on a committee to consider and report upon the question of fuel economy (utilisation of coal and smoke prevention), from a national point of view:—Prof. W. A. Bone, of the Imperial College of Science and Technology, London (chairman); Mr. E. D. Simon, chairman of the Manchester Air Pollution Committee (secretary); Profs. P. P. Bedson (Armstrong College, Newcastle-on-Tyne), J. W. Cobb and J. B. Cohen (Leeds University), H. B. Dixon (Manchester University), Thomas Gray (Royal Technical College, Glasgow), H. S. Hele-Shaw (London), L. T. O'Shea and W. P. Wynne (Sheffield University), and Richard Threlfall (Birmingham), together with Dr. G. T. Beilby (Glasgow), Mr. Ernest Bury, and Dr. J. E. Stead (Middlesbrough and the Cleveland district). The committee, which is empowered to add if necessary to its members, has been selected so as to include representative chemists, engineers, and technologists from all the principal industrial areas.

We are informed that the council of the University of Manchester has received from an anonymous benefactor the sum of 1368*l.* to pay off the debt which remained on the new extension of the museum that was added recently for the housing of the Egyptian antiquities and of collections of minerals.

An exhibition of photographs in monochrome and natural colours, by Mr. H. Essenhigh Corke, will be open free to the public, on presentation of visiting card, at the Royal Photographic Society of Great Britain, 35 Russell Square, W.C., until Saturday, November 27, daily from 11 a.m. until 5 p.m.

The death is announced, in his eighty-six year, of Mr. Charles Fortey, who was for many years honorary curator of the Ludlow Natural History Society's Museum. He is gratefully remembered by many geologists and palæontologists for the manner in which he made the unique collection of Upper Silurian fossils in his charge available for purposes of research.

The death is announced in *Science*, in his eighty-second year, of Prof. W. Watson, from 1865 to 1873 professor of mechanical engineering and descriptive geometry in the Massachusetts Institute of Technology, and since 1884 recording secretary of the American Academy of Arts and Sciences.

In 1903, at the International Geological Congress, Mr. Emmons, supported by the late Prof. E. Suess, proposed the establishment of an institute for the study of geological physics. A preliminary meeting was held on October 14, with Prof. Benjamin Moore in the chair, at which it was decided to form forthwith a society for the encouragement and study of geological physics, commencing with the subject of segregation in rocks. Under the presidency of Prof. Moore the society hopes to do good work by the exchange of specimens, photographs, and literature between its members. An annual subscription of 2*s.* 6*d.* has been fixed for the first two years. Communications are invited by the hon. sec. *pro. tem.*, Mr. G. Abbott, 2 Rusthall Park, Tunbridge Wells.

We mentioned in our issue of July 8 (p. 514) the case of an officer who had sent to the Natural History Museum at South Kensington the skins of some small animals trapped by him in the trenches in northern France. Dr. Ugolini, of the Royal Technical Institute at Brescia, Italy, writes to tell us that one of his four sons serving in the Italian Army, a doctor of natural science, has been able amid the perils of war on the high mountains of the Trentino, to make valuable geological observations, and to collect and dry plants of particular botanical interest. The keen naturalist always makes use of opportunities of acquiring knowledge; and no doubt many other instances could be given of the persistence of this ruling passion under conditions in which scientific work would scarcely be expected.

The death is announced, in the *Engineer* for October 15, of Mr. J. S. Graham, the general manager and a director of the Northumberland Shipbuilding Company, Ltd., of Howden-on-Tyne. Mr. Graham was born at Kingborn, Fifeshire, in 1864, and had varied experience in shipbuilding. A notable piece of work under his charge was the construction and delivery of the Havana pontoon dock. During the Spanish-American war he returned to this country, where he joined the Northumberland Shipbuilding Company in 1898.

The Aristotelian Society will begin its session on November 1 with the inaugural address by the president, Dr. Wildon Carr, on "The Moment of Experience." At the second meeting on December 6, Lord Haldane will read a paper on "Progress in Philosophical Research." Some papers of specially scientific interest are announced, including one by Prof.

Whitehead, on "Space, Time, and Relativity," and one by Prof. Nunn, on "Sense-data and the Physical Object." There will be two symposia, one on "Recognition and Memory," and one on "The Theory of the State."

THE death is announced, at eighty-two years of age, of Colonel T. E. Vickers, C.B., who played a leading part in the development of the great steel firm of that name. He was (says the *Times*) among the pioneers in the early 'seventies of the open-hearth process of melting steel, and achieved a great success, notwithstanding the paucity of scientific knowledge and the lack of instruments for ensuring precision in regard to temperature, etc. The River Don works, now one of the great industrial establishments of the country, were inaugurated in 1866, in order to meet the increased demands resulting from early successes, and since then developments have followed each other in rapid succession in connection with heavy forgings, gun-making, armour manufacture, shipbuilding, and corresponding industries, so that long before Colonel Vickers's retirement in 1909 the firm had become one of the most renowned in the world. Colonel Vickers was awarded the Howard quinquennial prize by the Institution of Civil Engineers, "in recognition of the part taken during his career in developing and improving the production of steel for important engineering purposes."

IN view of the possibility of fires which may arise from further attacks by hostile aircraft, the Commissioner of Police of the metropolis directs attention to the warning published in June last, recommending that a supply of water and sand be kept readily available for dealing with incendiary fires. It is suggested that chemical liquid fire extinguishers should not be purchased without a written guarantee that they comply with official specifications. The specification issued by the Board of Trade (Circular 1560) has reference to the ordinary type of extincteur in which water charged with carbonic acid gas is used as the extinguishing liquid; it indicates the chief points of construction, testing, and maintenance to which attention should be directed in connection with such apparatus. As regards dry powder fire extinguishers, the public is warned that no trust can be placed in them for effectively controlling fires such as are likely to be caused by bombs, whether explosive or incendiary. In dealing with such outbreaks of fire, the prompt and intelligent use of water or sand, or of both, is considered to be the best, simplest, and most economical procedure.

WE regret to announce the death of Dr. Charles Callaway, of Cheltenham, who was one of the pioneers in the study of the Archæan rocks of the British Isles. Dr. Callaway was born at Bristol in 1838, and was educated for the Nonconformist ministry, which he afterwards relinquished for education work and geology. In 1874, when he read his first paper before the Geological Society, much remained to be done in distinguishing the Cambrian rocks from those of earlier date, and in establishing the broader grouping of the latter. The extent of his geological work is shown by the fact that more than twenty papers by him have been published in the Quarterly Journal of the Geological Society, descriptive of the older rocks of Shropshire, the Malverns, Anglesey, Assynt and other regions in the north-west Highlands of Scotland, and parts of Ireland. In some of these regions he was the first to identify the occurrence of subdivisions of the Cambrian rocks and to ascertain their relation to the Archæan groups. In the latter he introduced the terms Uriconian and Longmyndian. The value of his work was recognised by the award to him in 1885 of the Wollaston Fund of the Geological Society, and in 1903 by the award of the Murchison medal. Among the more important of his papers in the Quarterly Journal of the Geological Society may be mentioned "The Pre-Cambrian Rocks of Shropshire" (1879–1882) and "The Age of the Newer Gneissic Rocks of the Northern Highlands" (1883), but many others have been published in the *Geological Magazine* and in the Proceedings of the Cotteswold Naturalists' Field Club, of which he was a past-president. Dr. Callaway was also a writer on ethical subjects.

To the October number of the *Fortnightly Review* Mr. J. B. C. Kershaw contributes an article on the scientific and engineering aspects of the war. It is pointed out that this is the first great war in which the striking advances of scientific knowledge of recent years have been allowed full play, and how great has been the influence in every direction. The subject is dealt with under four headings—the petrol motor and its application to land transport and aviation; smokeless powders and high explosives; the use of inflammable liquids and poisonous gases; the legal and moral aspects of some of these recent developments. The combination of high power with lightness in weight of the petrol motor rendered possible, first, the automobile, and then the dirigible balloon and aeroplane. The automobile has revolutionised the question of supplies to the front, and warfare on its present scale would otherwise have been impossible; troops fighting in districts long since denuded of food supplies are remarkably well catered for, and the inhabitants saved from starvation. The haulage of heavy siege guns, the use of armoured motor-cars, the rapid movement of troops, and the efficient motor ambulance service, all emphasise the utility of the petrol motor. The results from aviation are of immense importance—in directing and controlling artillery fire, and in observation work. Discussing explosives, the writer, having described briefly the compositon and characters of smokeless and high explosives, points out how the invisibility on discharge in daylight enables batteries to be hidden, and how the sniper is able to perform his deadly work undetected. The section on the use of inflammable liquids is largely historical, "Germany's step forward in this direction, however, in reality is a step backwards towards barbarism," the use of such methods dating back to very early times.

A VALUABLE memoir on the evolution and morphology of the Palæozoic star-fishes and brittle stars has just been published by the United States National Museum (Bulletin 88). The author, Mr. Charles Schuchert, re-

marks that throughout the Cambrian system not a single star-fish has yet been discovered, from which he infers that the skeleton was not evolved until the Lower Ordovician, "where they will surely be found." The Ordovician Hudsonaster he regards as the ancestor of the asterids of the Phanerozonia type. Numerous diagrams in the text and several excellent plates illustrate this difficult theme.

THE autumn number of *Bird Notes and News* contains much readable matter in regard to the effect of the war on bird-life in France and Flanders. Swallows returning this spring to their accustomed nesting sites only too often found them reduced to a heap of ruined masonry. In such cases huts erected for military purposes have been adopted as substitutes. This fact shows the tenacity with which these birds cling to their old haunts. Birds roosting between the lines of the opposing forces have on more than one occasion given timely warning to the sleeping men of the near approach of poison gas fumes, by the rustle of their wings and low cries as they passed over our trenches. Except, indeed, when actually within the zone of fire the birds have shown themselves strangely indifferent to the strife around them. Some valuable data in regard to birds in relation to agriculture are also given in this number.

THE *Psychological Bulletin* (vol. xii., No. 8) contains a valuable summary of recent literature on habit formation, imitation, and higher capacities, in animals. The difficult task of summarising the work done in this field has been skilfully performed by Mr. John Shepard. All kinds of animals have been experimented on, from fiddler-crabs to monkeys. A series of studies carried out with pigs, by Messrs. Yerkes and Coyurn, on the multiple choice method, convince the authors that they have established an approach to "free ideas" in that animal. Though visual and kinæsthetic factors in the main determine the responses, the pig, they consider, is more independent of the particular situation than is the crow. The same number also contains a similar summary, by Mr. K. S. Lashley, on sensory discrimination in animals. The experiments recorded are mainly those concerned with responses to light, sound, touch, and smell. Echinoderms, molluscs, and insects, frogs, birds, and various mammals furnished the material for these investigations.

THE October number of *Irish Gardening* contains some extracts of letters written in August by Mr. C. F. Ball, the editor, to Sir F. W. Moore, in which some interesting accounts of the vegetation on the Gallipoli peninsula are given. It is with great regret that we have received the news that Mr. Ball was recently killed in action in the Dardanelles. Mr. Ball, who received his horticultural training at Kew, was assistant to the keeper of the Royal Botanic Gardens, Glasnevin, and, on the outbreak of the war, volunteered for service, and enlisted in the 7th Royal Dublin Fusiliers.

THE new garden plants described in English and foreign botanical and horticultural publications during the year 1914 are brought together in a complete list in appendix iii. of the Kew Bulletin. Some 350 new plants, varieties and hybrids, are enumerated. In the case of hybrids the parentage, where known, is given, and the place of origin. In the case of new plants a brief description is appended, the country of origin stated, and the name of the introducer. This publication, which is produced annually at Kew, should prove indispensable to the maintenance of a correct nomenclature, and affords valuable information in a concise form respecting new plants under cultivation, abstracted from a very large number of scattered publications.

A CENSUS report on the mosses of Ireland occupies No. 7, section B, of vol. xxxii. of the Proceedings of the Royal Irish Academy. As far as possible the earliest and latest known records are given for each species, except in the case of the commonest and widely distributed species. The divisions of Ireland adopted in Mr. Praeger's "Irish Topographical Botany" are used. Since the publication of David Moore's "Synopsis of the Mosses of Ireland" in 1872, 118 mosses new to Ireland have been recorded, and forty-two of these are recorded for the first time in the present report. The list of records is preceded by a very interesting account of the progress of muscology of Ireland, giving details of the various collectors and their contributions. John Ray is the first to mention mosses in Ireland, and these were probably collected by William Sherard, of Oxford. To David Moore our knowledge of the mosses of Ireland is very largely due, and he added sixty-seven species and varieties to the Irish flora. A useful bibliography of papers dealing with Irish mosses is also included in the report.

THE second part of Father E. Blatter's "Flora of Aden" has recently been published as vol. vii., No. 2, of the Records of the Botanical Survey of India. Part i., which appeared in 1914, consisted of a general account of the flora and of the physical aspects of the country, and was accompanied by a large scale map of the district; the present part deals entirely with a systematic account of the flora. A synopsis of the natural orders—Ranunculaceæ to Urticaceæ—is given, and the families, genera, and species are fully described; keys are also given for the genera and species. The indigenous species number 250, distributed under 138 genera; 33 of these species belong to the grasses, 32 to the Leguminosæ, 18 to the Capparidaceæ, 13 to the Euphorbiaceæ, 11 to the Chenopodiaceæ and Boraginaceæ, and 10 to the Compositæ. Most of the other families are represented by only one or two species. It is of interest to notice that the three plants belonging to the family Burseraceæ found at Aden are the well-known myrrh, *Commiphora abyssinica*; balm of Gilead, *Commiphora opobalsamum*; and frankincense, *Boswellia Carterii*, about which Father Blatter gives some interesting historical details. Much of our information about the flora of Aden is due to the collections of passing travellers, who may have spent only a few hours on shore, but their labours brought together in systematic form make a valuable contribution to our knowledge of the little-known vegetation of southern Arabia.

THE origin of certain valleys in Cleveland, Cumberland, and elsewhere, which have generally been attributed to overflow streams from ice-dammed lakes, has been investigated by Prof. T. G. Bonney. His conclusions are published in a pamphlet ("On Certain Channels," Bowes and Bowes, Cambridge, 1915). Prof. Bonney contends that these channels are relics of an ancient drainage system, in the case of the Cleveland ones, post-Jurassic, if not post-Cretaceous, and in the case of the Cumberland ones, probably pre-Triassic; but, at any rate, in all cases long anterior to the Ice age.

IN the Bulletin of the American Geographical Society (vol. xlvii., pp. 672–80) Prof. R. de C. Ward returns to the discussion of the climatic subdivisions of the United States. Such divisions must be chosen in relation to cyclonic and anticyclonic tracks and movements, and local and characteristic weather distribution around high and low pressures. Changes in climate in the United States are met with in going east and west, and not north and south. The climatic subdivisions must therefore be separated by meridional and not latitudinal lines. East and west boundaries are largely arbitrary. The main divisions arrived at are five, an eastern province and a gulf province, both bounded on the west by the 2000-ft. contour, that is, about 100° W., a plateau province extending west to the generalised line of the main Rocky divide, a plateau province bounded on the west by the Sierra Nevada-Cascade divide, and a Pacific province. The last three are subdivided into northern and southern regions about 43° N.

THE use of a new type of submarine for hydrographical work is described by Mr. Simon Lake in the *Scientific American* (vol. cxiii., No. 13, September 25). The submarine employed is connected with a surface vessel by an access tube. Power is transmitted from a dynamo on the surface vessel to the submarine, which is provided with a single pair of toothed driving wheels at its bows, capable of being turned in any direction. From the air chamber in the submarine a diver can leave the vessel to examine the sea bottom. The author advocates the use of this type of vessel in pairs for harbour contouring. Two such vessels, each with its surface vessel, and linked together by two wires, the upper for telephoning purposes, and the lower one to locate obstructions, steer parallel courses half a mile apart. Any obstruction between the submarines would cause a pull on the wire, and the rock could then be located by one of the vessels steering towards it, reeling in the wires as it went. Mr. Lake omits to say whether his method has proved practicable. If successful it would certainly give more accurate hydrographical data than can be obtained by the sounding machine alone.

AN earthquake was felt throughout a large part of Cumberland and in the surrounding counties on October 2 at about 3.15 a.m. The disturbed area, which extends from Newcastleton in Dumfriesshire on the north to Langdale and Troutbeck on the south, and from Silloth on the west to beyond Kirkoswald on the east, is about fifty-five miles long from north to south, and about thirty-seven miles wide, and contains about 1600 square miles. It thus seems almost co-extensive with the disturbed area of the Carlisle earthquake of July 9, 1901 (Quart. Journ. Geol. Soc., vol lviii., 1902, pp. 371–6). This earthquake, according to Dr. Davison, was a twin earthquake, originating in a long deep-seated fault directed N. 5° E., underlying the complicated formations of the Lake District. The principal focus was situated seven miles south-south-west of Carlisle, the other more than twenty miles to the south.

PROF. A. McADIE discusses temperature inversions in relation to frost (Blue Hill Meteorological Observations, Cambridge, U.S.A., 1915). He seems to find more difficulty in explaining the radiation frosts that occur in sheltered valleys than there really is, for the commonly given explanation is quite simple and meets the facts so far as they are known perfectly. The first requirement is free radiation, which means absence of cloud of any kind and also absence of water vapour in the overlying air strata; the second is absence of wind. Given free radiation, the ground is rapidly cooled, and imparts its coldness to the bottom layer of air. When this occurs on the summit or slope of a hill the cold air simply runs off down the slope just as water would do, and its place is taken by warmer air from above; hence on the summit or slope there is no great fall of temperature. But on a plane or in a valley bottom the case is different, because the chilled air cannot run off and the chilling effect of radiation is continued upon the same air, which therefore reaches a low temperature. Under such conditions there is naturally a sharp temperature inversion a short distance above the ground. Absence of wind is a further requisite because wind would mix up the different layers of air, thus warming the lower and cooling the higher, but with free radiation at night there is generally a calm on the surface, though there may be a good breeze a little way up. Prof. McAdie then discusses the artificial means by which damage to growing crops may be reduced or avoided.

PROF. E. BUCKINGHAM, of the Washington Bureau of Standards, sends us several recent papers by him dealing with the principle of similarity and the method of dimensions as applied to the formulation of equations representing physical results. Two of these papers are published in the *Physical Review*, iv., 4 (October, 1914), and the Journal of the Washington Academy of Sciences, iv., 13 (July, 1914). In addition, we have a communication to the American Society of Mechanical Engineers, read in June, 1915, and a letter to the *Electrician* (January 15, 1915) criticising Becker's formula for the windage of fly-wheels, on the ground that the terms are not all of the same dimensions. It is remarkable how prone not only students, but experienced mathematicians and engineers are to write down equations which are obviously of wrong dimensions. After giving numerous illustrations of the method, Prof. Buckingham points out that the method is purely formal and algebraical. If certain quantities and no others are connected by a physical relation, the equation connecting them must necessarily be of a certain form. Any mistake must be due to overlooking one of the

variables on which the result depends. The process cannot supply any new facts. We only get out what we put in, but this is generally in a much more useful form than the original assumptions. It is to be hoped that a study of Prof. Buckingham's papers may lead to a diminution of the mass of unwarrantable deductions and unsound formulæ that now finds its way into scientific and more especially technical literature. We need only instance the rule that "no purely arithmetical operator such as log or sin can be applied to an operand which is not a pure number," as one of the laws which is most often overlooked.

The leading article in *Engineering* for October 15 discusses the second and final report, just issued, of the Departmental Committee on bulkheads and watertight compartments presided over by Sir Archibald Denny. The report deals with passenger steamers trading to the Continent between the limits of Brest and the Elbe, in the channels surrounding the British Isles, also those plying on short excursions round the coast, and on rivers, estuaries, lakes, and canals. The fundamental principle underlying the recommendations is the same as that in the first report dealing with ocean-going vessels. A difficulty arises in dealing with the classes of ship to which the second report refers, owing to the overlapping in the principal features of design of the respective types; also the sizes of vessels vary greatly. These considerations involved difficulty in stringently applying rules general to all types. It seems probable, however, that the general recommendations of the committee will be acceptable to all; no doubt the exceptions will be considered on their merits by the authorities. It is of interest to note that Channel steamers are treated more severely than oversea passenger steamers in the matter of bulkhead doors—doors worked from the bridge alone are permitted.

Mr. John Murray's new announcements include:—Vegetable Fibres, by Dr. E. Goulding (in the "Imperial Institute Handbooks"); A History of the Gold Coast and Ashanti from the Earliest Times to the Beginning of the Twentieth Century, by W. W. Claridge, 2 vols.; and new editions of The Study of Animal Life, by Prof. J. Arthur Thomson, illustrated, and Geometry: an Elementary Treatise on Theory and Practice, by S. O. Andrew.

OUR ASTRONOMICAL COLUMN.

Selenium Cell Photometry of δ Orionis.—Some years ago Prof. Joel Stebbins announced that measures of the light of δ Orionis by means of the selenium photometer indicated that this remarkable stellar system was also an eclipse-variable, although visual observation had failed to establish any alteration of magnitude. An extensive series of measures of the feeble fluctuations of its light was secured during the years 1910–11–12 (*Astrophys. Journ.*, September). The only spectroscopic orbit then available was Hartmann's memorable determination which revealed the first example of fixed calcium lines. These elements were used in deducing the light-curve, but the complete discussion was held up whilst Prof. R. H. Curtiss re-investigated the radial velocity variations, and these new elements have been employed in the discussion of the dimensions of the system. The variation of brightness is only 0·15m., of which 0·08m. is considered due to eclipses. The presence of a resisting medium such as the calcium envelope suggested by Hartmann's discovery would help to explain the brightness near periastron, which is a feature of the light-curve. It is only possible to fix limits for the dimensions of the system. The minimal values possible for the radii of the two bodies are 5 times and 1·4 times solar, and the mean density of the system is found to be 0·006 solar.

The Plane of the Solar Motion.—Criticism of the hypothesis of star-streaming has led to several attempts to develop a gravitational idea of the stellar universe. Thus Prof. H. H. Turner, in 1912, and just about a year earlier Prof. von S. Oppenheim, both suggested that stellar motions were orbital in character, the stars oscillating or revolving about an ideal centre distant from the sun. The solar system itself contains a model closely representing Prof. Oppenheim's conception in the swarm of minor planets viewed from the earth. This fact has again been made of use in an investigation of the solar motion (No. 4813, *Astronomische Nachrichten*), affording means of testing the formulæ employed in deducing the plane of the sun's path from astrometric data by permitting a determination of the known plane of the earth's orbit from the geocentric movements of the minor planets. Ephemerides of 265 minor planets gave mean motions, etc., of the bodies comprised in every two hours of R.A. Reduction by the Bessel-Kobold method hence gave twelve pairs of values of the position of node and inclination of the earth's orbit; eleven showed fair agreement, and yielded the highly satisfactory mean values $\Omega=0^\circ\ 44'$, $i=22^\circ\ 0'$, instead of 0° and $23^\circ\ 27'$ respectively. The application to the case of the solar motion was made on the basis of data from Charlier's second memoir. The resulting mean values for all Charlier's areas taken together were $\Omega=234^\circ\ 45'$ and $i=50^\circ\ 15'$, corresponding solar apex R.A. $267^\circ\ 58'$, declination $+31·56$; whilst for the galactic areas considered apart the mean values were $\Omega=245^\circ\ 30'$ and $i=58^\circ\ 25'$, apex R.A., $261^\circ\ 4'$, declination, $+23^\circ\ 27'$. Charlier's values were based, it may be recalled, on the proper motions in the P.G.C. of Boss.

Displacement of Photographic Stellar Images.—A curious announcement by M. J. Comas Sola (*Astr. Nach.*, 4814) states that among the stars recorded in successive slightly displaced exposures on the same plate and stellar region, occasionally some pairs of images indicate considerable real or apparent movement in the corresponding star. An example is given. It is added that it is extremely rare that such a displacement appears twice in the same star.

The Solar Eclipse, August 21, 1914.—Prof. Störmer, together with several colleagues, went to Vefsen to observe the eclipse (*Vid. Selk. Forh.*, No. 5, 1915, Christiania). The observers took up stations at Laksfors and 35 km. to the south at Svennigviken, prepared to secure, should the opportunity arise, parallax photographs of auroræ. Favoured by fine weather and clear skies, unfortunately no auroræ were seen, but the cameras were used in taking a large number of snapshots of the corona, including seventy exposures with a kinematograph. Considering the extremely small scale of the pictures, the form of the corona is very well shown in the reproductions.

UPPER AIR TEMPERATURES.[1]

THIS interesting publication of fifty-eight pages gives an account of some fifty to sixty ascents made at Batavia, Java, and over the neighbouring seas. Batavia lies in the latitude of 5° S., and observations from a place so near the equator are of especial value; these observations also were designed for the purpose of giving information on several interesting points.

The first half of the book gives the detailed account of each ascent, that is to say, the temperature and relative humidity at each 100 metres both on the ascent and descent, and the second half discusses the results obtained. The first point discussed is the thickness of the land wind at night and the temperature inversion. The highest temperature was found at 170 metres, and the depth of the land breeze was 130 metres. The high pressure which prevails over Australia in winter, the winter, that is, of the southern hemisphere, sometimes stretches as far northwards as Batavia, and interesting figures relating to one of these periods are given. Very similar conditions seem to prevail there as in Europe in anticyclonic areas; on rising from the surface, a decrease of temperature with an increasing humidity is met with, but at a height between 2·0 and 3·0 km. excessive dryness with a temperature inversion, or at least a great slackening in the temperature gradient, occurs.

These observations do not depend on kite or balloon observations alone, since the summits of some of the mountains are high enough to give similar records.

In England, the dreary type of anticyclonic cloud that so often covers the sky for days together in winter nearly always, perhaps always, lies just under a sharp inversion of temperature and a layer of excessively dry air, but the height of this inversion seldom reaches 2 km. In Batavia, the cloud layer is replaced by a sheet of moist air in which small cumuli prevail (in the daytime). In both cases the damp and the dry strata are sharply divided, and Dr. Braak discusses the reasons of this arrangement. There cannot be much doubt that the extreme dryness is due to the air having descended from a colder, and therefore dryer, level, dryer, that is, in the sense of having a smaller amount of water vapour; but dry air, as Tyndall pointed out long since, cannot radiate or absorb radiation with any freedom. Probably radiation from the vapour of the damp strata, which can occur freely through the dry air above, has a good deal to do with the formation of the cloud, especially the sea, but they are not numerous enough to show the magnitude with any certainty.

The daily temperature change by day over the sea and the nightly change over the land are also discussed. Dr. Braak finds over the land in the early afternoon a gradient from 0 to 300 m. of 1·34° per 100 m. Over the sea he finds practically no daily change at the sea surface, the amplitude being about one-third of a degree, but the value increases somewhat up to 600 m. The observations suffice to show that there is little daily change of temperature over the sea, but are not numerous enough to show the magnitude with any certainty.

Some interesting remarks are made on the fall of temperature at night, and on an irregularity in the change. The double daily oscillation of the barometer in low latitudes is quite sufficient to produce measurable changes of temperature. It is so commonly stated that the adiabatic change of temperature in air is produced by change of height that one is apt to overlook the fact that change of height by itself is absolutely without effect upon temperature, and that the rise or fall is due to pressure changes only, change of pressure being usually, but by no means always, due to change of height.

W. H. DINES.

1 "Koninklijk Magnetisch en Meteorologisch Observatorium te Batavia.' Verhandelingen No. 3. Drachen Freiballon- und Fesselballon-berbachtungen. Von Dr. C. Braak. Pp. 58. (Batavia: Javasche Boekhandel en Drukkerij.)

A MANX TRIBUTE TO EDWARD FORBES.

THE London Manx Society has issued a report of the meetings held in London on February 13 to celebrate the centenary of the birth of Edward Forbes. The report ("Edward Forbes, Great Manx Naturalist, Botanist, Geologist, Zoologist," 45 pp., 1s.) contains an address by Sir Archibald Geikie, Forbes's biographer, on his life and geological work, appreciations of his zoological work by Prof. Ewart, Prof. McIntosh, and Prof. Herdman, and of his botanical work by Prof. Bottomley; also contributions by Prof. Boyd Dawkins, Mr. Whitaker, and Dr. J. W. Evans, a letter by Mr. Ulrich on behalf of the Palæontological Society of the United States, and the words of Forbes's "Dredging Song." Forbes was born in 1815 in the Isle of Man, and was educated in Edinburgh; in 1841 he was appointed naturalist to H.M.S. *Beacon* during her survey of the Ægean Sea and coasts of Asia Minor. The following year he became Professor of Botany at King's College, which he held, for part of the time, together with the appointments of Palæontologist to the Geological Survey and Lecturer on "Natural History as applied to Geology" at the Royal School of Mines, until his election to the chair of Natural History in Edinburgh in 1854. His death a few months later was, according to Sir Archibald Geikie, "one of the most grievous losses which British science has sustained in our time." His work was remarkable for its wide range, brilliant originality, and philosophic insight. Huxley wrote of him in 1851 that "he has more claims to the title of a philosophic naturalist than any man I know in England." Some of his conclusions on the relations of the British flora to fauna were rejected by his contemporaries and immediate successors, but, according to Prof. McIntosh and Dr. Scharff, they have been established in the main. Mr. E. V. Ulrich, of Washington, reports that Forbes's teaching has "exerted a profound influence on palæontologists the world over," that the principles he enunciated now "assume a commanding importance," and that probably no British author on his subjects has been more followed and quoted in America than Forbes. Forbes was a man of great literary distinction; he was a first-class humorist, and a frequent contributor to *Punch*; and Sir Joseph Hooker has recorded that owing to his talents and his personality "he was beloved and admired beyond any natural historian of his day."

EDUCATION AND INDUSTRY.[1]

I.

THE British Association, by establishing Section L, has recognised education as a branch of science and made provision for its advancement.

But education—I am speaking of that part of it in which human educators intervene—is still regarded as belonging to politics and literature, rather than to economics and physiology. To many people the very title of this paper, "Education and Industry," will appear incongruous. Is there not a great gulf fixed, say they, between hazy views of education high in the clouds above, and the hard facts of science or technology far in the depths beneath?

1 Abridged from a paper read to the Educational Science Secti n (L) of the British Association on September 11, by Principal J. C. Maxwell Garnett.

And yet the intimate relation of education to industry is obvious enough. Of all that goes to make industry possible, let alone prosperous, the human element is the most important. We are careful to select suitable land, we know that capital or credit is essential to us, and we take pains to see that our capital is represented by the most suitable works, machinery, and material. But we commonly take little interest in producing the necessary men to undertake, design, direct, and manipulate the work.

It is true that industry exists for men, not men for industry; and it follows that to train men for industry cannot be the whole end of education. How far the specific training of men for their particular occupations is legitimate can only be decided when we know what the true aim of education really is. Upon the answer to this fundamental question educators are not agreed.

But agreement should not be altogether out of reach if only we would treat education as a natural science. We should then endeavour to keep our thought about education in the closet possible touch with facts, especially physiological facts; we should think and speak, not only of the mind or soul, but also of the cortex of the cerebrum, through which alone the soul can be reached by human educators. When facts are available we should use them, and follow George Eliot's advice not to replace them by metaphors, or mixed metaphors like that of the broad foundation of general culture. When facts are not available we should, if possible, ascertain them by direct experiment; and, if that is not possible, we should have faith—that is, we should ascertain the facts indirectly by acting on an hypothesis with a view to its verification or modification by subsequent experience. That is how progress has been made in other branches of knowledge, and that is how the advancement of the science of education must also be effected. Moreover, the ground so won must be consolidated by the use of some esoteric or symbolic language; for at present our most precise conceptions, being expressed in words that are used every day with many different meanings, receive from each of our hearers or readers a different interpretation.

Consider, for example, the word "character." Perhaps the most generally accepted statement of the aim of education is that of the opening sentence of the introduction to the public elementary school code: "The purpose . . . is to form and strengthen the character. . . ." But this statement fails to produce any clear conception, because it does not define "character," a word which means different things to different people, and which to most people, perhaps, conveys no clear meaning at all. If, however, we reflect that since two men who, when placed in the same circumstances, always did the same thing, would, for practical purposes, be indistinguishable, we realise that men are characterised by their actions: by their fruits they are known. If then we inquire what it is that determines an individual's actions we find—as I have attempted to show in a recent paper [2]—that in addition to the sensory stimuli arising from the environment of the moment, the determining factors are interest, instinct, and will, together with the habits they have helped to form. These, then, are the foundations of character. A further inquiry shows that, if character is to be strong, two conditions must be fulfilled: in the first place, interest must be single and wide, combining the whole range of the individual's experience into one group of inter-associated ideas and including central ideas which strongly move the emotions (instincts); and secondly, the will must co-operate with this single wide interest and its central group of instincts in guiding thought and action.

2 Published in *Manual Training* for May, 1915.

It follows that if the purpose of education is to form and strengthen character, the proximate aim of education must be to develop a single wide interest—a single complex of inter-connected neurograms.

If the citizens we are educating are to have characters that are not only strong, but also good—that is, if each citizen is to be anxious to serve his neighbours—the emotional element at the heart of his wide interest must be rich in brotherly love. Education without religion is impossible.

If the individual citizens are to be not only anxious, but also able, to serve each other, they must be prepared to divide labour among themselves so as to minister to the economic well-being of the community. The more a man's knowledge or skill differs from that of other people the better in general can he serve his fellow-men. As the occupations of different individuals must differ, and as all the ideas that come to each in the course of his daily work are to form part of his single wide interest, it follows that the single wide interests of different individuals must differ according to their different occupations; and the great interest which each man will then take in his work will incidentally make for his economic efficiency. It is true that these single wide interests must also overlap, so that different individuals may share as far as possible each other's interests and have at least their interest in the State in common. The extent of this overlapping of interests should be limited only by the consideration that during the educand's last two or three years at school—or, if he proceeds to college, then during his university course—his education should have the specific aim of preparing him for his particular work in life, including not only the work for which he is paid, but the whole of what Kim would call his "great game." The need for this application to education of the principle of continuity, so familiar in other branches of natural science, has been thus expressed by the Board of Education's Consultative Committee: "The nearer a pupil is to his entrance into life, the more steadily must the actual practical needs of his occupation be kept in view, and the more decided, therefore, must be the bent of his education to that end." [3]

Finally, education must train the will. The power of the will to focus attention—to direct nerve impulses into a particular system of nervous arcs—is the supreme intellectual faculty, and the only faculty that can be trained. Whoever is to have most creative or abstract thinking to do, most needs this skill in thinking.

II.

These conclusions have been separately proclaimed by several high authorities.

"Milton," said Prof. Perry last year from the presidential chair of this section, "taught me the true notion of education, that the greatest mistake is in teaching subjects in water-tight compartments" [4]; in fact, education must aim at building up a *single* wide interest.

"Thorough knowledge of one subject and practice in it," said Goethe, "produces higher culture than incomplete knowledge of a hundred subjects." [5]

Ruskin had no doubt about the need for specific education. "The idea," he wrote, "of a general education that is to fit everybody to be Emperor of Russia . . . is the most entirely and directly diabolical of all the countless stupidities into which the British nation has of late been betrayed." [6]

"The whole evolution of educational theory," according to Prof. Adams, "may be said to be a

3 Report on Higher Elementary Schools (1906), p. 11.
4 Nature, October 1, 1914.
5 Quoted by Dr. Kerschensteiner, "Schools and the Nation," p. 256.
6 "Fors Clavigera," p. 254.

great sweep from specific education back to specific education, through a long period during which formal training held the field."[7]

Finally, William James maintained that "The faculty of voluntarily bringing back a wandering attention over and over again, is the very root of judgment, character, and will. . . . An education which should improve this faculty would be the education *par excellence*."[8]

III.

We shall now assume the truth of these conclusions and proceed to discuss the problem of so educating every individual that he shall possess, in the first place, the single wide interest which his particular service to the community most needs for its efficiency; and secondly, skill in thinking—the capacity of voluntarily focusing his attention.

We have first to investigate the qualities—the type of single wide interest and the degree of skill in thinking—required by those who are to be engaged in various classes of industrial occupation; and afterwards to indicate a means of developing the required qualities in a sufficient number of persons, selected on account of their innate aptitudes for each different kind of work.

The first classification to suggest itself is that of the various branches of industry, such as engineering, building, chemical manufacture, the textile industry, and the like. But the qualities required in the manager of an engineering works have more in common with those needed by the manager of a chemical works or of a cotton mill than with the qualities sought for in the lowest grades of labour employed in any of these industries. In the same way the designer of electrical machinery will generally have more in common with the professional physicist than he has with the engineering tradesman who makes what he designs.

We shall find it convenient to adopt the following classification :—

Class A.—Industrial statesmen; chief designers; research engineers, chemists, etc.; consulting engineers, etc.

Class B.—Works managers and heads of departments; junior members of designing, testing, and managerial staff.

Class C.—Foremen and leading hands; skilled tradesmen.

Class D.—Machinemen and repetition workers; unskilled labourers.

No essential discontinuities are to be imagined between these classes; nor are the occupations named to be regarded as forming complete lists of the classes of work they are intended to indicate.

We have already remarked that every occupation includes that of citizen. We have next to consider the special, or distinguishing, features of each different class of occupation.

It is clear that each class is concerned, in the course of daily work, with a greater *variety* of ideas than the class next below it. Accordingly, trains of thought of members of class A must on the average be fresher, and therefore less governed by habit, than those of members of classes B, C, or D. "The controllers of the great industry," writes Mr. Graham Wallas, "are always on the look out for that type of man whom Americans call 'a live wire.' For such a man secretaries and typists and foremen carry on all that punctual performance of habitual acts which took up so much of the time and labour of a merchant or manufacturer even fifty years ago. He is set to form a habit of non-habituation. . . ."[9] Such a man requires more emotional drive than one who is engaged in mere routine work. And since his ideas cover so wide a range, they are not so naturally associated together as those which their daily work brings to members of classes B or C or D. He therefore needs to weld his various ideas into a single wide interest by making voluntary associations between them; and in order to make such associations, especially between dissimilar ideas, he needs skill in thinking.

So, then, class A requires a wider interest, a stronger emotional element in that interest, and more skill in thinking—but not necessarily more pay—than class B, class B than class C, and class C than class D.

Let us now look more closely at each of these classes. The first named on our list is that of the industrial statesman. We know him already as the captain of industry. But he has lately changed his name, for the title of captain does not indicate with sufficient clearness the fact that the head of a great industrial firm must needs concern himself with much that is happening outside the establishments which he controls. Not only must he be familiar with the state of the markets from which he draws his supplies and in which he disposes of his products, but, by grasping the significance of economic, social, and political changes all over the world, he must be able to foresee opportunities for developing his business according to a far-reaching policy, and to indicate the lines of technological research which are most likely to lead to such developments. Work of this kind involves the widest sort of knowledge. But beware of the professional administrator who is prepared to administer anything at a moment's notice. The statesman—whether industrial or not—must possess, in addition to a wide range of knowledge and much skill in thinking, a very special interest in the particular concern he is directing, whether that concern is his own small business or an empire the destinies of which are under his control. He must see that concern as a whole, and must love it. "Without passion," said Lord Haldane to the students of Edinburgh University, "nothing great is, or ever has been, accomplished."[10]

Lord Haldane went on to compare the statesman with the expert, greatly to the latter's disadvantage. Much that has happened lately would probably cause Lord Haldane to express himself differently now. In any case we shall not follow him here. We shall instead place the expert in the same class as the industrial statesman because the former requires an equally high degree of skill in thinking and at least as complex (if not so widely varied or so emotional) an interest as the latter. The industrial statesman may be compared to the astronomer who uses the telescope to increase his grasp of the whole, while the expert rather resembles the naturalist whose microscope enables him to see the parts in great detail. It is evident that the successful development of industry demands not only the expert in special branches of science or technology, but also the industrial statesman who co-ordinates the work of experts in different fields, and who is himself enough of a specialist fully to understand his experts, to command their confidence, and, when necessary, to decide between them. Whoever has authority must also have knowledge.

The members of class B require fewer associations to connect the ideas which constitute their single wide interests. They need less skill in thinking than members of class A. They require, on the other hand, a very wide descriptive knowledge of material

7 "Evolution of Educational Theory," p. 225.
8 "Principles of Psychology," vol. ii., p. 424.

9 "The Great Society," p. 87.
10 "The Conduct of Life," p. 25.

things, and as much of this knowledge as possible they should have acquired at first hand from direct sense impressions. Last, but by no means least, the works manager and his immediate assistants need to interest themselves in the social and economic welfare—including the further education, recreation, and housing—of all their employees, and this interest will help to form the nucleus of those single wide interests which are to include all the activities of members of class B.

Foremen and leading hands have hitherto been generally recruited from among skilled tradesmen. They are therefore presumed to be qualified themselves to perform every task they have to supervise, and even to perform it better than the men who are actually doing the work. Upon this presumption is based the claim that the shop foreman must be paid a higher wage than any workman under him. This view, accepted as it generally is by employers and employed alike, is responsible for no small restriction of output. But it is based on a misconception, since the foreman is paid for supervising men, and the workman for manipulating material—two quite incommensurate processes. There are, however, signs of change. Technically trained foremen whose wages may (to start with) be much less than those of the men they have to look after, are already being employed, especially in shops where much repetition work is done. Yet it remains true that the qualities now most sought for in foremen and leading hands are those of the craftsman whose interest is centred in his manual work.

The operative skilled tradesman whom, for this reason, we have placed in the same class as his foreman is distinguished from the machine man in class D in that the operative in class C has a *variety* of skilled work to do, while the members of class D who may do skilled work, *repeat* the same process over and over again until its performance is governed by habit, so that it almost ceases to receive attention. On the one hand, ideas connected with *doing*, like ideas associated with a strong instinct, are peculiarly liable to receive attention, so that the work of the skilled tradesman in class C is well able to form a strong centre for his single wide interest. On the other hand, ideas connected with the repetition work of class D tend to become circumscribed and cut off from other interests. There is, however, reason to believe that repetition work is not altogether uninteresting to a certain type of mind. It is, indeed, actually preferred by some people, including many women. Such work may, therefore, form a substantial, if not a dominant, part of an interest that is not rich in exciting ideas. The remaining part of the single wide interest is of special importance in the case of class D. When an eight-hours day is universal it may be that the artisan or labourer who leaves work with much of his day still before him and feeling pleasantly exercised rather than unduly tired by his somewhat monotonous but by no means exacting labour, will devote himself increasingly to national and municipal affairs. With that end in view we must see to it that the average member of class D receives —not only in maturity through the Workers' Educational Association, but also in youth through vocational part-time classes—the kind of training which shall best develop a single interest, wide enough to include the highest ideals of patriotism as well as loyalty to a particular industrial class.

IV.

We have next to consider how to develop in a sufficient number of suitably selected persons the qualities which we have indicated as specially needed in each class of industrial occupation.

Childhood up to, say, twelve years of age has few organised interests. Accordingly, the need for a coherent curriculum, aiming at developing a single wide interest, does not obtrude itself until adolescence begins. The future member of classes A and B will normally spend much of his adolescence in a secondary school. Of these schools it is convenient to distinguish two types, named "Higher" and "Lower" respectively in the accompanying diagram.

The chief function of the secondary school, the school for adolescents, is to foster the growth of true religion—"not theology nor yet ethics, but personal and experimenetal"[11]—and around this centre to build up, out of the miscellaneous information obtained in childhood and the coherent curriculum which the secondary school should itself provide, the beginnings of that single wide interest which should continue to grow throughout maturity. The skill in thinking which the secondary school must also cultivate is best practised upon a number of closely associated ideas—a coherent interest—because, unless the idea before consciousness at any moment calls up *many* others, from which the will can select that which is next to receive attention, this faculty cannot be practised; and without practice skill in thinking cannot be developed.

The broad foundation metaphor, of which Dr. Kerschensteiner[12] has made such fine fun, is probably responsible for the fact that most secondary schools aim in theory, and some lower secondary schools (unfortunately) in practice also, at comprehensiveness rather than at coherence of interest: they have failed to realise that coherence at seventeen is the surest way to comprehensiveness at twenty-seven. Concentration has, however, been practised by the classical sides of English public schools. But in many of the newer secondary schools six or seven distinct subjects are taught out of all relation to one another by as many separate specialists, and the form master himself is almost unknown!

The future member of class A should remain at his higher secondary school and enter the university at, or soon after, the age of eighteen. It is true that the future engineer often spends some time in works between school and college; but there is a growing consensus of opinion that this period should not be too long. Perhaps from Christmas until the following October would be ideal if both school-leaving and university-entrance scholarships could be awarded, as those of some Oxford and Cambridge colleges already are, just before Christmas.

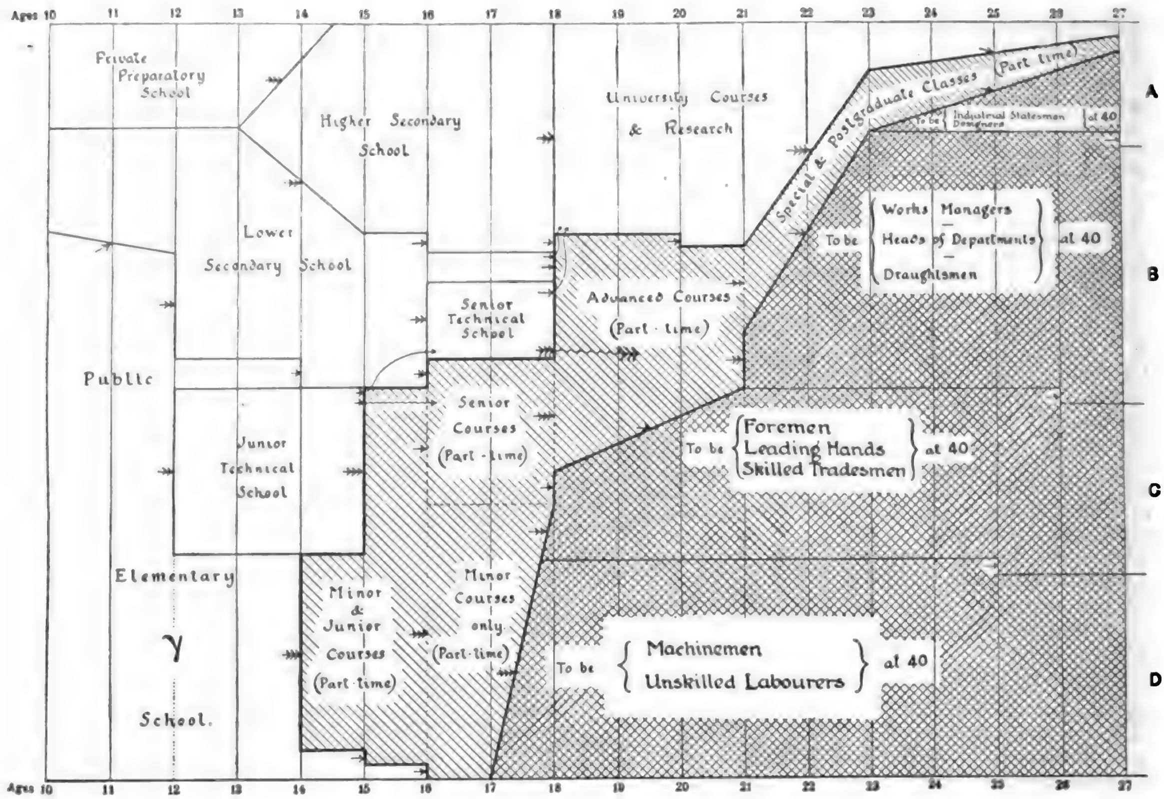
It is to the university that we shall principally look in the future for an essential part of the specific training of members of class A, for the men with creative minds, inventors of new appliances and processes, men who shall not merely be able to follow existing practice but also to cope with new problems and even to lead in new lines of advance. And our university courses, if they succeed in producing men of this type, will do so, not because of the knowledge they impart, wide though it be, but because of the stress they lay on the acquisition of skill in thinking along with knowledge. It is skill in thinking—skill in applying old knowledge to new situations—rather than knowledge itself without such skill, that now, as always, marks the really practical man. If, in fact, his university course can, in Huxley's phrase, give him "real, precise, thorough, and practical knowledge of fundamentals," the candidate for membership of class A may well wait for subsequent works experience, post-graduate evening classes, and private reading, to develop further his *technical* information to a marketable standard. Whatever letters he may

11 G. Stanley Hall, "Adolescence," vol. ii., p. 326.
12 "Schools and the Nation," p. 275.

be able to write after his name, his undergraduate course should have aimed at making him a bachelor of arts, skilled in the art of learning, and only incidentally have given him a body of scientific knowledge capable of immediate application.

This view of the chief aim of a university course insists that there shall not be overmuch lecturing; that information shall be acquired because it is immediately and urgently needed for the solution of some practical problem; that a larger proportion of the most able students shall remain "up" after taking their degrees for the purpose of undertaking original course must be at all detached from practical things. It is no more possible to develop skill in thinking without knowledge than to acquire skill in the use of tools without material to work upon. Technical knowledge is, in fact, a most excellent foundation and medium for cultivating skill in thinking.

England is fortunate in that most of her highest study and research in technology form part of the work of her universities. For a university is more than a university course or an aggregate of such courses. The opportunities which a university affords for studying elective



EDUCATION AND INDUSTRY.

Diagram illustrating proposed modification of present organisation.

HORIZONTAL SCALE: The spaces between adjacent vertical lines represent one year.

VERTICAL SCALE: The vertical scale increases from the bottom of the diagram to the top. The intercept made on any ordinate by the enclosed area which corresponds to any course varies with (but not strictly in proportion to) the number of students of the corresponding age who should be following the course in question.

—>>> / —>> / —> indicates that the great majority of the / a constant supply of systematically selected / a few exceptional persons leaving the course which corresponds to the area in which the arrow-head lies should proceed to the course towards which it points.

The unshaded portion of the diagram is concerned with "full-time" education; that is, with schools and classes meeting in the daytime and occupying all the working hours of those by whom they are attended. The central singly shaded area relates to part-time classes: classes meeting either in the day or in the evening, and intended for persons whose employment occupies the greater part of their time. The doubly shaded region on the right of the diagram corresponds to those later years of industrial practice when a man has ceased to attend organised courses of study bearing upon his trade or profession.

research; and that, while the most distinguished professors shall take part in the teaching of the undergraduates from the outset, they shall do so, not because of the knowledge they are peculiarly able to impart, but because "the personal influence of the man doing original work in his subject inspires belief in it, awakens enthusiasm, and gains disciples."[13]

In urging that the chief aim of a university course must be to cultivate skill in thinking rather than to impart information, we do not mean that such a subjects are important. But far more important is the intimate and constant association in the various students' societies, as well as in the lecture rooms, drawing offices, or laboratories, between students in different faculties, from different countries, and with entirely different outlooks.[14]

But the State cannot afford to provide a university training for all its citizens. The majority, even of class B, will be compelled by economic pressure to begin earning money before they are twenty years

[13] Final Report of the Royal Commission on University Education in London, p. 29.

[14] See Newman's eloquent words quoted by the Royal Commission on University Education in London (*loc. cit.*, pp. 26, 27).

old. Where a suitable senior technical school exists, they will do well to receive in it the specific training which should occupy the last two years before their entry into industrial life. The very important place which a senior technical school should fill in the educational system of an industrial district is, as yet, hardly realised.

The future member of class C should be transferred from the public elementary school to the junior technical school when other children are transferred to the lower secondary school. The junior technical school should prepare him for entering one of a group of allied trades at or about the age of fifteen. It is not, however, the function of the junior technical school to teach him a trade, but rather to develop his manual skill in work that is closely related to that of the trade to which he is looking forward, and to extend the great interest which he cannot help feeling in such work so as also to include so-called "general" subjects. Experience has shown that he will thus make more progress in these "general" subjects than if he were studying them in a school which has no specific aim.

When the future members of classes A, B, and C have been transferred from the public elementary schools at the age of twelve, the work of the future members of class D who are left behind should differ[15] somewhat from the general work done by all children below the age of twelve. It might well be centred in (but not, of course, be confined to) handwork during these last two years, and so have much in common with the training of Boy Scouts.

Even when the last two years of whole-time education have been admirably adapted to prepare the educand for his imminent vocation, some educational discontinuity must always occur as he leaves whole-time school or college to continue his education in industrial life. Part-time classes afford the best means of reducing this discontinuity to a minimum. Accordingly, every boy or man, as he first enters upon industrial work, should attend suitable part-time classes. No feature of English education is more striking to the foreign observer than the system of part-time courses in all our great centres of industry. At the present time most part-time courses involve attendance on three evenings a week for several successive years. Although they cannot cover the whole ground of university courses, they aim (for the most part) at affording an alternative means of training men to occupy positions of responsibility in industrial affairs.

While, however, our part-time classes are thus training technical men, they are neglecting manual workers. Instead of attending these technical classes, the boy who enters works at fourteen or fifteen years of age requires (at least until he is seventeen years old) a special type of part-time course, to which the name "minor course" has lately been given. One of the principal objects of such a course is to provide instruction in those matters which the trade apprentice in bygone days learned by close association with a master craftsman, and which are commonly lost to him under modern industrial conditions. The minor course will therefore "have as its central subject the trade processes or craft in which the students are engaged."[16] But so-called "citizenship" subjects—such as history and economics, the study of which will make for a better understanding of problems concerning wages and hours of labour—also form an essential part of a minor course. It remains to add that the need for minor courses is not yet sufficiently appreciated, with the result that a great opportunity of educating during the critical years of adolescence the numerous members of class C and class D is being neglected.

15 The difference is marked by the dotted line at y in the diagram.
16 Board of Education Circular 894.

V.

The system of education, the outline of which I have thus described, is represented on paper in the diagram. Its realisation in any English industrial district—say, Manchester—would need some, but not much, co-ordination; for the diagram represents neither what is nor what might be under ideal conditions, but what could be made out of what is with the maximum of advantage in proportion to the effort spent in making the change. The co-operation of local education authorities, universities, the Government, employers, and parents would be required in order to complete this change.

But already there are signs that all the necessary co-operation is forthcoming. Many striking instances might be cited in support of this statement did time permit. I must, however, be content to mention only two: Mr. Henderson's new scheme for the organisation and development of industrial research, and a similar scheme recently prepared by a committee of the Manchester Engineers' Club. This latter scheme provides for organised co-operation between schools, colleges, and engineering firms in the education of engineers and for the encouragement of research in the following, among other ways:—

> By developing co-operation between engineering firms on the one hand and universities and technical colleges on the other, so as to establish such "schools of thought" as exist in the research departments of great Continental and American engineering firms, but cannot be fostered in the comparatively small establishments (and smaller research departments) of most British engineering firms.

VI.

The co-ordinated system of schools, colleges, and works represented in the diagram will not be satisfactory unless it is thoroughly democratic. It is true that innate differences between individuals cannot well be distinguished from differences produced by home surroundings. But whoever is best fitted by nature and nurture for any particular class of occupation should be selected to receive, if necessary at the State's expense, the training which will best prepare him for it. Education authorities should see that the number of persons so selected is sufficient—but not much more than sufficient—to supply whatever demand is also a need.

VII.

At present the supply of men for the highest classes of work falls very far short of the demand. Every year the number of appointments offered to School of Technology graduates greatly exceeds the number of these graduates. Not only is this true of posts in chemical works, but also of electrical and other engineering appointments. Although the number of undergraduates in the School of Technology (Faculty of Technology in Manchester University) increased by 50 per cent. in the two years before the war, the demand for their services after graduation increased in a still larger proportion.

Such facts need to be realised by boys and by their parents. But it is even more important that they should realise that the highest kind of technological work is noble work, worthy of a lifetime's duration. The profession of applying science to industry is rich in opportunities for helping to bring about the ideal

future of the human race. While it is the glory of the medical profession, for example, that it assists in preventing a wastage of life that could not but retard human progress, we must remember that technology helps to produce what medicine and surgery help to preserve. The great increase in population which began in the middle of the eighteenth century was directly due to mechanical invention. Indeed, the application of science to industry not only renders possible a rapid growth of population, but it exempts an ever-growing proportion of this increasing population from the need for incessant physical toil. Moreover, all that acceleration of human progress which results from the increasing national expenditure on the education of the people would cease with any interruption of the march of technological invention.

Every improvement, then, which the technologist may be able to make in the direction of cheapening production—reducing, for example, the cost of a brake horse-power hour—will help to increase the number of men whom the community can spare for the study of classical literature in order to keep the thought of our time in touch with the best of the thought of ancient Greece and Rome; it will help to increase, too, the number of those who can be spared by this generation to devote their lives to scientific research, to widen the scope of human thought, to teach men more of the works and ways of God, and to obtain the knowledge which technologists of the future will apply for the benefit of generations not yet born; and, most important of all, it will help to support the seers and the prophets on whom we so largely depend in the weightiest affairs of human life.

THE BRITISH ASSOCIATION.

SECTION M.

AGRICULTURE.

OPENING ADDRESS BY R. H. REW,[1] C.B., PRESIDENT OF THE SECTION.

Farming and Food Supplies in Time of War.

BEFORE considering the position of farming in the present war, we may briefly glance at its position when a century ago the nation was similarly engaged in a vital struggle.

From February, 1793, until 1815, with two brief intervals, we were at war, and the conflict embraced not only practically all Europe but America as well. The latter half of the eighteenth century had witnessed a revolution of British agriculture. The work of Jethro Tull, "Turnip" Townshend, Robert Bakewell, and their disciples, had established the principles of modern farming. Coke of Holkham had begun his missionary work; Arthur Young was preaching the gospel of progress; and in 1803 Humphry Davy delivered his epoch-making lectures on agricultural chemistry. Common-field cultivation, with all its hindrances to progress, was rapidly being extinguished, accelerated by the General Inclosure Act of 1801. A general idea of the state of agriculture may be obtained from the estimates made by W. T. Comber of the area in England and Wales under different crops in 1808. There were then no official returns, which, indeed, were not started until 1866; but these estimates have been generally accepted as approximately accurate, and are at any rate the nearest approach we have to definite information.

I give for comparison the figures from the agricultural returns of 1914, which approximately correspond to those of the earlier date:—

	1808 Acres	1914 Acres
Wheat	3,160,000	1,807,498
Barley and rye	861,000	1,558,670
Oats and beans	2,872,000	2,223,642
Clover, rye-grass, etc.	1,149,000	2,558,735
Roots and cabbages cultivated by the plough...	1,150,000	2,077,487
Fallow	2,297,000	340,737
Hop grounds	36,000	36,661
Land depastured by cattle ...	17,479,000	16,115,750

The returns in 1914 comprise a larger variety of crops than were cultivated in 1808. Potatoes, for instance, were then only just beginning to be grown as a field-crop, and I have included them, together with Kohl-rabi and rape, among "roots and cabbages."

The population of England and Wales in 1801 was 8,892,536, so that there were 35½ acres under wheat for every hundred inhabitants. In 1914 the population was 37,302,983, and for every hundred inhabitants there were 5 acres under wheat.

The yield of wheat during the twenty years ending 1795 was estimated at 3 qr. per acre[2]; in 1914 it was 4 qr. per acre. The quantity of home-grown wheat per head of population was therefore 8½ bushels in 1808, and 1½ bushels in 1914. Nevertheless, even at that time, the country was not self-supporting in breadstuffs. In 1810, 1,305,000 qr. of wheat and 473,000 cwt. of flour were imported. The average annual imports of wheat from 1801 to 1810 were 601,000 qr., and from 1811 to 1820 458,000 qr. Up to the last decade of the eighteenth century England was an exporting rather than an importing country, and bounties on exports were offered when prices were low, from 1689 to 1814, though none were, in fact, paid after 1792.

During the war period we are considering, the annual average price of wheat ranged from 49*s.* 3*d.* per qr. in 1793 to 126*s.* 6*d.* per qr. in 1812; the real price in the latter year, owing to the depreciation of the currency, being not more than 100*s.* In 1814 the nominal price was 74*s.* 4*d.* and the real price not more than 54*s.* per qr.[3] The extent to which these high and widely varying prices were affected by the European war has been the subject of controversy. As we mainly depended on the Continent for any addition to our own resources, the diminished production during the earlier years in the Netherlands, Germany, and Italy, and in the later years of the war in Russia, Poland, Prussia, Saxony, and the Peninsula, reduced possible supplies. At the same time the rates of freight and insurance, especially in the later years of the war, increased very considerably. Tooke mentions a freight of 30*l.* per ton on hemp from St. Petersburg in 1809. On the other hand, a powerful impetus was given to home production, which was stimulated by Government action and private enterprise. Inclosure was encouraged by the General Inclosure Act of 1801, and 1934 Inclosure Acts were passed from 1793 to 1815. The schemes for increasing and conserving food supplies were various. The Board of Agriculture, for example, offered prizes of 50, 30, and 20 guineas respectively to the persons who in the spring of 1805 cultivated the greatest number of acres—not fewer than 20—of spring wheat.[4] In 1795 a Select Committee recommended that bounties should be granted to encourage the cultivation of potatoes on

1 Slightly abridged by the author.

2 Report of Select Committee on the means of promoting the cultivation and improvement of the waste, uninclosed and unproductive lands of the kingdom. 1795.

3 Porter's "Progress of the Nation," by F. W. Hirst. p. 183.

4 "Annals of Agriculture," 1805.

"lands at present lying waste, uncultivated, or unproductive," and that means should at once be adopted to add at least 150,000 and perhaps 300,000 acres to the land under cultivation "as the only effectual means of preventing that importation of corn, and disadvantages therefrom, by which this country has already so deeply suffered."

The main cause of high prices and scarcity was the failure of the harvests. Mr. Prothero thus analyses the wheat harvests of the twenty-two years 1793–1814: "Fourteen were deficient; in seven out of the fourteen the crops failed to a remarkable extent, namely, in 1795, 1799, 1800, 1809, 1810, 1811, 1812. Six produced an average yield. Only two, 1796 and 1813, were abundant; but the latter was long regarded as the best within living memory."[5]

It appears paradoxical, but in a sense it is true, to say that the scarcity of wheat in certain years arose from the fact that the country was too largely dependent on its own crop. The risk of a bad harvest in a climate such as that of the British Isles must always be serious, and by the fortune of war this risk between 1793 and 1814 turned out to be very high. When supplies are drawn from the four quarters of the globe, it is evident that the risk of a shortage in time of peace is greatly reduced. Whether in a great war it is preferable to be more dependent on the sea than on the season is debatable.

In comparison with wars for national existence, such as that against Napoleon, and in a still sterner sense that in which we are now engaged, other conflicts appear insignificant. The Crimean War, however, did affect our food supplies and had a reflex action on British agriculture. The cessation of imports from Russia caused a rise in the price of corn. The average price of wheat rose to 72*s*. 5*d*. per qr. in 1854, 74*s*. 8*d*. in 1855, and 69*s*. 2*d*. in 1856. Only once before (in 1839) during the previous thirty-five years had it risen above 70*s*. There were then no agricultural returns, but the estimates of Lawes, which were generally accepted, put the area under wheat at a little more than 4,000,000 acres, a higher figure than has been suggested for any other period. It is, indeed, highly probable that the Crimean War marked the maximum of wheat cultivation in this country. It was a time of great agricultural activity and of rapid progress. To their astonishment, farmers had found, after an interval of panic, that the Repeal of the Corn Laws had not obliterated British agriculture, and that even the price of wheat was not invariably lower than it had often been before 1846. Caird had preached "High Farming" in 1848 and found many disciples, capital was poured into the land, and the high prices of the Crimean period stimulated enterprise and restored confidence in agriculture.

To generalise very roughly, it may be said that while the Napoleonic wars were followed by the deepest depression in agriculture, the Crimean War was followed by a heyday of agricultural prosperity which lasted for more than twenty years. What the agricultural sequel to the present war may be, I leave to others to estimate, and I turn to consider briefly some of its effects on British farming up to the present time.

Harvest had just begun when war broke out on August 4; indeed, in the earlier districts a good deal of corn was already cut. The harvest of 1914 was, in fact, with the exception of that of 1911, the earliest of recent years, as it was also one of the most quickly gathered. The agricultural situation may perhaps be concisely shown by giving the returns of the crops then in hand, *i.e.* in course of gathering or in the ground, with the numbers of live stock as returned on farms in the previous June. The figures are for the United Kingdom, and I add the average for the preceding ten years for comparison:—

	1914	Average 1904–13
	Qr.	Qr.
Wheat	7,804,000	7,094,000
Barley	8,066,000	7,965,000
Oats	20,664,000	21,564,000
Beans	1,120,000	1,059,000
Peas	374,000	525,000
	Tons	Tons
Potatoes	7,476,000	6,592,000
Turnips and swedes ...	24,196,000	26,901,000
Mangold	9,522,000	9,934,000
Hay	12,403,000	14,148,000
	Cwt.	Cwt.
Hops	507,000	354,000
	No.	No.
Cattle	12,185,000	11,756,000
Sheep	27,964,000	29,882,000
Pigs	3,953,000	3,805,000
Horses	1,851,000	2,059,000

Farmers had thus rather more than their usual supplies of nearly every crop, the chief deficiencies being in peas, roots, and hay. The shortage of the hay crop was, however, in some measure made up by the large stocks left from the unusually heavy crop of 1913. It was fortunate from the food-supply point of view that two of the most plentiful crops were wheat and potatoes. The head of cattle was very satisfactory, being the largest on record, and pigs were well above average. Sheep, always apt to fluctuate in numbers, were much below average, the total being the smallest since 1882 with the exception of 1913.

On the whole, it was a good year agriculturally, and the supply of home-grown produce at the beginning of the war was bountiful. Nature at any rate had provided for us more generously than we had a right to expect.

At first it appeared as if farmers were likely to be sufferers rather than gainers by the war. Prices of feeding-stuffs, especially linseed and cotton-cakes, maize-meal, rice-meal, and barley-meal, rose at once, recruiting affected the labour supply, and difficulties arose in the distribution of produce by rail. With one or two exceptions, such as oats, the prices of farm produce showed but little rise for three or four months after the war began. Wheat rose about 10 per cent., barley remained about normal, cattle by November had not risen more than 3 per cent., sheep and veal-calves showed no rise until December, while poultry was actually cheaper than usual, though eggs rose considerably. Butter rose slightly, and cheese remained about normal. Up to nearly the end of the year, in fact, it may be said generally that British farm-produce made very little more money than usual.

Meanwhile, the nation began to take a keen interest in the agricultural resources of the country, and farming became the object of general solicitude. We started with great energy to improvise, in truly British fashion, the means of facing the supreme crisis of our fate, but the elementary fact at once became obvious that it is impossible to improvise food. The main farm-crops take an unreasonably long time to grow, even if the land is prepared for them, and a sudden extension of the area under cultivation is not a simple proposition. It was freely pointed out—with undeniable truth—that our agricultural system had not been arranged to meet the conditions of a great European war, and many suggestions were made to meet the emergency. Some of these suggestions involved intervention by legislative or administrative action. It was decided that any attempt violently to

5 "English Farming, Past and Present," p. 269.

divert the course of farming from its normal channels would probably not result in an increased total production from the land. The Agricultural Consultative Committee, appointed by the President of the Board of Agriculture on August 10, issued some excellent advice to farmers as to their general line of policy and the best means by which they could serve the nation, and this was supplemented by the Board and by the agricultural colleges and local organisations throughout the country. No fewer than thirty special leaflets were issued by the Board, but, while it may, I think, fairly be claimed that all the recommendations made officially were sound and reasonable, I should be the last to aver that farmers were universally guided by them. They do not accept official action effusively:—

> Unkempt about those hedges blows
> An English unofficial rose,

and official plants do not flourish naturally in farm hedgerows. It was, however, fairly evident that patriotism would suggest an effort to obtain the maximum production from the land, and there were good reasons to think that self-interest would indicate the same course. It must be admitted, however, that during the autumn the lure of self-interest was not very apparent. Food-prices, however, at the end of the year began to rise rapidly. English wheat in December was 25 per cent. above the July level, in January 45 per cent., in February and March 60 per cent., and in May 80 per cent. Imported wheat generally rose to a still greater extent, prices in May standing for No. 2 North Manitoba 95 per cent., and No. 2 Hard Winter 90 per cent. above July level. The greater rise in imported wheat may be noted as vindicating farmers against the charge which was made against them of unreasonably withholding their wheat from the market. Cattle and sheep rose more slowly, but in March prices of both had risen by 20 per cent., and in May and June cattle had risen by about 40 per cent. Butter rose by about 20 per cent., and cheese by about 40 per cent. Milk rose little through the winter, but when summer contracts were made prices remained generally at the winter level.

British agriculture, like the British Isles, is a comparatively small affair geographically. The 47 million acres which it occupies, compared with the 80 million acres of Germany or the 90 million acres of France, and still more the 290 million acres of the United States, represent an area which may be termed manageable, and about which one might expect to generalise without much difficulty. But, in fact, generalisation is impossible. Even on the 27 million acres of farm land in England and Wales there is probably more diversity to the square mile than in any country on earth. The variations in local conditions, class of farming, and status of occupier preclude the possibility of making any general statement without elaborate qualifications. Thus whatever one might say as to the effects of the war on agriculture would be certain to be inaccurate in some districts and as regards some farmers.

There are three main agricultural groups, corn-growing, grazing, and dairying. They overlap and intermingle indefinitely, and there are other important groups, such as fruit-growing, vegetable-growing, hop-growing, etc., which represent a very large share of the enterprise and capital engaged on the land. The receipts of the corn-growing farmer, generally speaking, were substantially increased. Probably about 50 per cent. of the wheat-crop had been sold before prices rose above 40s. per quarter, and there was very little left on the farms when they reached their maximum in May. Oats rose rather more quickly, but did not reach so high a level, relatively, as wheat. Barley—owing perhaps to enforced and voluntary temperance—never made exceptional prices, and, in fact, the best malting barleys were of rather less than average value. There is no doubt, however, that farmers who depended mainly on corn-growing found an exceptionally good market for their crops and made substantial profits. Farmers who depended mainly on stock were less generally fortunate, although stock were at a fairly high level of price when the war began. Sheep for some time showed no signs of getting dearer, but in the spring prices rose substantially, and a good demand for wool—which in one or two cases touched 2s. per lb.—made the flockmasters' returns on the whole very satisfactory. Cattle followed much the same course; stores were dear, but by the time fat stock came out of the yards or off the grass prices had risen to a very remunerative level. The large demands on imported supplies of meat for the British and French armies occasioned a distinct shortage for the civil population, but this was relieved by a reduced demand, so that the effect upon prices of native beef and mutton was not so great as might have been expected. The influence of a rise of price upon demand is more marked in the case of meat than in that of bread. While there has been a distinct reduction in the consumption of meat, there is no evidence of a reduced consumption of bread.

Dairy farmers generally found themselves in difficulties. Prices of butter and cheese increased but slightly, and milk remained for a considerable period almost unchanged. The rise in the prices of feeding-stuffs and the loss of milkers aggravated their troubles. An actual instance of the position in February as affecting a fairly typical two-hundred acre farm may be quoted. It had thirty milch cows producing about 16,500 gallons per annum. The cake bill showed an advance of 50 per cent., and wages had risen 12 per cent. It was calculated that the extra cost was 1·3*d.* per gallon of milk. Later the prices of milk, butter, and cheese rose, but on the whole it cannot be said that dairy farmers generally made exceptional profits.

While it is certain that the gross receipts by farmers were substantially increased, it is very difficult to estimate what the net pecuniary gain to agriculture has been. It can only be said generally that while some have made substantial profits, which were probably in very few cases excessive, many others have on balance (after allowing for extra cost) done no better financially, and some perhaps even worse, than in an average year of peace. With regard to one item of extra cost, that of labour, it is possible to make an approximate estimate. Agricultural labourers were among the first to respond to the call for the new armies, and, up to the end of January, 15 per cent. had joined the forces of the Crown. This considerable depletion of labour was not acutely felt by farmers during the winter, but during the spring and summer serious difficulty was experienced and many devices were suggested—some of which were adopted—for meeting it. Naturally the wages of those agricultural labourers who were left rose, the rise varying in different districts but being generally from 1*s.* 6*d.* to 3*s.* per week. Owing to the rise in the price of commodities, this increase of wages cannot be regarded as a profit to the labourers, but it is, of course, an outlay by farmers, which in England and Wales may be reckoned as amounting to an aggregate of about 2,000,000*l.*

This country has never suffered from a dearth of agricultural advisers, and in such a time as the present, when everyone is anxious to help the country, it is natural that they should be unusually plentiful. Advice was freely offered both to the Government how to deal with farmers and to farmers how to deal with

the land. Whether in consequence of advice or in spite of it, it may fairly be said that farmers throughout the United Kingdom have done their duty. They have met their difficulties doggedly, and have shown an appreciation of the situation which does credit to their intelligence. It was not easy last autumn when farmers had to lay their plans for the agricultural year to forecast the future. We were all optimists then, and many thought that the war might be over before the crops then being planted were reaped. It was clear, however, that the national interest lay in maintaining and, so far as possible, increasing the produce of the land. In the quiet, determined way which is characteristic of them, farmers devoted themselves to the task, and the returns recently issued give the measure of their achievement. They have added 22 per cent. to the acreage of wheat and 7 per cent. to the acreage of oats, and they have kept the area of potatoes up to the high and sufficient level of the previous year. These are the three most important crops. They have also not only maintained the stock of cattle, which was the largest on record, but, in spite of unfavourable conditions and a bad lambing season, they have increased the stock of sheep. In view of these facts, I venture to say that British and Irish farmers have shown both patriotism and intelligence, and may fairly claim to have contributed their share to the national effort.

The share of British agriculture in the food supply of the nation is more considerable than is sometimes realised. When I last had the honour to address the British Association I ventured to emphasise this point, and I may be allowed to repeat, in a somewhat different form and for a later period, the figures then given. Taking those articles of food which are more or less produced at home, the respective proportions contributed by the United Kingdom, the rest of the Empire, and foreign countries were on the average of the five years 1910–14 as follows:—

—	United Kingdom	British Empire overseas	Foreign countries
	Per cent.	Per cent.	Per cent.
Wheat	19·0	39·3	41·7
Meat	57·9	10·7	31·4
Poultry	82·7	0·2	17·1
Eggs	67·6	0·1	32·3
Butter (including margarine)	25·1	13·3	61·6
Cheese	19·5	65·4	15·1
Milk (including cream) ...	95·4	0·0	4·6
Fruit	36·3	8·3	55·4
Vegetables	91·8	1·1	7·1

The war has directly affected some of our food supplies by interposing barriers against the exports of certain countries. Fortunately we were in no way dependent for any of these foods upon our enemies, though Germany was one of our main sources of supply for sugar. We received some small quantities of wheat or flour and of eggs from Germany, Hungary, and Turkey, some poultry from Austria-Hungary, and some fruit from Germany and Turkey, but the whole amount was insignificant. The practical cessation of supplies from Russia was the most serious loss, as we drew from thence on an average 9 per cent. of our wheat, 9 per cent. of our butter, and 16 per cent. of our eggs.

Within the first few days of the war, the Government, through the Board of Agriculture, obtained returns not only of the stocks of all kinds of foodstuffs in the country, but also of the stocks of feeding-stuffs for animals and of fertilisers for the land. Powers were taken under the Articles of Commerce (Returns, etc.) Act to compel holders of stocks to make returns, but it is due to the trading community to say that in only two instances, so far the Board of Agriculture was concerned, was it necessary to have recourse to compulsion. The returns of stocks of food-stuffs, feeding-stuffs, and fertilisers have been made regularly to the Board of Agriculture[6] every month since the outbreak of war, and the loyal co-operation of the traders concerned deserves cordial recognition by those whose official duty has been rendered comparatively easy by their assistance.

A very casual glance at the national dietary suffices to show that John Bull is an omnivorous feeder, and as the whole world has eagerly catered for his table his demands are exigent. But, for various reasons, our daily bread, reluctant though most of us would be to be restricted to it, is regarded as the measure and index of our food supplies. On August 4 the Board of Agriculture published an announcement that they estimated the wheat-crop then on the verge of harvest at 7,000,000 quarters, and that, including other stocks in hand, there was at that time sufficient wheat in the country to feed the whole population for four months; and a few days later, having then obtained further information from about 160 of the principal millers, they stated that the supplies in the country were sufficient for five months' consumption. The Board also announced, on August 5, that the potato crop would furnish a full supply for a whole year's consumption without the necessity for any addition from imports. When it was further announced that the Government had taken steps to ensure against a shortage of sugar it began to be generally realised that at any rate the country was not in imminent danger of starvation. Indeed, on a broad survey of the whole situation, it was apparent that our native resources, together with the accumulated stocks of various commodities held in granaries, warehouses, and cold stores, would enable the United Kingdom to face even the unimaginable contingency of a complete blockade of all its ports for a considerable period.

In these circumstances it appeared that, provided adequate protection were given against unusual risks, commercial enterprise might in the main be relied upon to supply the demands of the people in the normal manner and in the usual course of business. It is a self-evident axiom that it is better not to interfere in business matters unless there is a paramount necessity for interference.

The machinery of modern business in a highly organised community is very complicated; the innumerable cog-wheels are hidden while the machine is running normally, but every single one of these becomes very obvious when you attempt to introduce a crowbar. With one or two exceptions the purveyors of food to the nation were left to conduct their business without official interference, though the Board of Trade took steps to ascertain what were the retail prices justified by the wholesale conditions and to disseminate the information for the protection of consumers against unreasonable charges.

One measure of a drastic and widespread nature was adopted. The exportation of a large number of commodities was prohibited. This was done for two reasons: (1) to conserve stocks in this country, and (2) to prevent goods from reaching the enemy. The latter object could be attained only very partially by this method so long as any sources of supply other than the ports of the United Kingdom were open to the enemy or to adjoining neutral countries. The former object—with which we are now only concerned—was on the whole achieved. The Board of Agriculture, concerned for the maintenance of our flocks and herds, at once secured a general prohibition of the exportation

6 Returns in Scotland and Ireland are made to the Agricultural Departments of those countries and the results transmitted to the Board of Agriculture and Fisheries.

of all kinds of feeding-stuffs for animals. Many kinds of food-stuffs were at once included, and later additions were made, so that for a long time past nearly all kinds of food have been included, though in some cases the prohibition does not apply to the British Empire or to our Allies. The exportation of fertilisers, agricultural seeds, binder twine, and certain other commodities more or less directly connected with the conservation of our food supplies, was also prohibited, so that generally it may be said that the outlet for any food in the country was under effective control. This is not the time or place to discuss the reasons why in some instances limited quantities of certain articles were allowed to escape under licence. It is only necessary to remark that in all such cases there were cogent reasons in the national interest for the action taken.

Direct Government intervention in regard to food supplies was limited to three commodities—sugar, meat, and wheat. In the case of sugar the whole business of supply was taken over by the Government—a huge undertaking, but administratively a comparatively simple one, owing to the fact that there are no home-grown supplies. Intervention in the meat trade was necessitated by the fact that the enormous demands of the Allied armies had to be met by drafts upon one particular kind of meat and mainly from one particular source. The Board of Trade co-operated with the War Office, and a scheme was evolved whereby a very large part of the output of meat from South America and Australia comes under Government control.

As regards wheat, the intervention of the Government took two forms. The scheme whereby the importation of wheat from India was undertaken by the British Government, in co-operation with the Indian Government, arose primarily from conditions in India rather than from conditions in the United Kingdom, although it is hoped and believed that the results will prove to be mutually advantageous. Other than this the intervention of the Government in regard to wheat was devised as an insurance against the risk of interruption of normal supplies, its main object being to prevent the stocks of wheat in the country from falling to a dangerous level at a time when the home crop would be practically exhausted. When the home crop is just harvested there are ample reserves in the country for some months, and, as the United States and Canada are at the same time selling freely, stocks held by the trade are usually high. While home-grown wheat remains on the farms it is practically an additional reserve supplementary to the commercial reserves. When it leaves the farmer's hands, even although it may not actually go into consumption, it becomes part of the commercial reserve. This reserve in the nature of business tends to be constant, but fluctuates within rather wide limits under the influence of market conditions. If the price of wheat rises substantially and the capital represented by a given quantity increases, there is a natural tendency to reduce stocks. If also there is any indication of a falling market ahead, whether from favourable crop prospects or the release of supplies now held off the market for any reason, a prudent trader reduces his stocks to the smallest quantity on which he can keep his business running. So long as shipments reach this country, as in normal times they do, with, as a member of the Baltic once expressed it to me, "the regularity of 'buses running down Cheapside," the country may safely rely on receiving its daily bread automatically. But if any interruption occurred at a time when the trade, for the reasons just indicated, happened to be running on low stocks, the margin for contingencies might be insufficient. I am, of course, debarred from discussing the method adopted or the manner in which the scheme was carried out, but, as the cereal year for which it was devised is over, it is permissible to state that the object in view was successfully achieved.

Of the 47,000,000 people who form the population of the United Kingdom the large majority are absolutely dependent for their daily food on the organisation and regular distribution of supplies. The countryman, even if he possesses no more than a pig and a garden, might exist for a short time, but the town-dweller would speedily starve if the organisation of supplies broke down. He does not, perhaps, sufficiently realise the intricacy of the commercial arrangements which make up that organisation, or the obstacles which arise when the whole economic basis of the community is disturbed by a cataclysm such as that which came upon us thirteen months ago. The sorry catchword, "Business as usual," must have sounded very ironically in the ears of many business men confronted with unforeseen and unprecedented difficulties on every side. The indomitable spirit with which they were met, the energy and determination with which they were overcome, afford further evidence of that which has been so gloriously demonstrated on land and sea, that the traditional courage and grit of the British race have not been lost.

To the question how have our oversea food supplies been maintained during the first year of the war, the best answer can be given in figures.

Imports of the principal kinds of food during the first twelve months of the war were as under, the figures for the corresponding period of 1913–14 being shown for comparison:—

	1914–15 Thousands of cwt.	1913–14 Thousands of cwt.	Increase + or Decrease − per cent.
Wheat (including flour)	113,797	115,398	− 1·39
Meat	15,868	18,026	− 11·97
Bacon and hams...	7,452	5,975	+ 24·72
Cheese	2,766	2,386	+ 15·93
Butter (including margarine) ...	5,376	5,748	− 6·47
Fruit	18,830	17,512	+ 7·53
Rice	9,573	4,840	+ 97·79
Sugar	35,029	38,356	− 8·67

In total weight of these food-stuffs, the quantity brought to our shores was rather larger in time of war than in time of peace. Yet one still occasionally meets a purblind pessimist who plaintively asks what the Navy is doing. This is a part of the answer. It is also a measure of the success of the much-advertised German "blockade" for the starvation of England. So absolute a triumph of sea-power in the first year of war would have been treated as a wild dream by the most confirmed optimist two years ago. The debt which the nation owes to our sailor-men is already immeasurable. That before the enemy is crushed the debt will be increased we may be assured. The crisis of our fate has not yet passed, and we may be called upon to meet worse trials than have yet befallen us. But in the Navy is our sure and certain hope.

"That which they have done is but earnest of the things that they shall do."

Under the protection of that silent shield the land may yield its increase untrodden by the invading foot, the trader may pursue his business undismayed by the threats of a thwarted foe, and the nation may rely that, while common prudence enjoins strict economy in husbanding our resources, sufficient supplies of food will be forthcoming for all the reasonable needs of the people.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Oxford at the beginning of Michaelmas Term, 1915, presents an unwonted appearance. The colleges are almost denuded of undergraduates; the river, playing grounds, and other usual resorts are comparatively deserted, and many of the accustomed activities are at a standstill. The city is redeemed from utter desolation by the presence of large numbers of young officers, who are sent here from their respective units to undergo a course of instruction by the staff of the Officers Training Corps, assisted by lecturers detailed from the War Office. Accommodation for this influx of the military element has been provided by several of the colleges, notably by Trinity, Wadham, Hertford, and Keble. The current number of the *University Gazette* contains a long list of members of the University who have given their lives for their King and country. Many of the scientific staff are being employed in researches and practical operations with direct reference to the war. Among these may be mentioned the names of Mr. R. B. Bourdillon, fellow of University, Mr. H. T. Tizard, fellow of Oriel, and Mr. I. O. Griffith, fellow of St. John's, who are all engaged in most important researches in the chemistry and physics of aerial warfare. Mr. Griffith has been specially re-elected to a fellowship in virtue of his research work in this department.

The new chemical laboratory, which is being erected under the supervision of Prof. Perkin, is rapidly approaching completion.

THE Swiney lectures on geology in connection with the British Museum (Natural History) will be delivered by Dr. J. D. Falconer, in the Lecture Theatre of the Victoria and Albert Museum, South Kensington, on Mondays, Tuesdays, and Saturdays, at 3 p.m., beginning Saturday, November 13. There will be twelve lectures, and their subject will be "Ice and the Ice Age." Admission to the lectures will be free.

A COPY of the current calendar of University College, Dublin, a constituent college of the National University of Ireland, has been received. It contains detailed particulars of the various courses offered in preparation for the degrees conferred by the National University. Among such degrees we notice the bachelor of agricultural science, bachelor and master of engineering, bachelor and master of architecture, and bachelor and master of commerce. In addition to other scholarships and exhibitions, the governing body is prepared to award not more than five post-graduate scholarships in arts or science.

THE Departmental Committee appointed by Lord Selborne under the chairmanship of Sir Harry Verney, Bart., M.P., to consider what steps can be taken to promote the settlement or employment on the land in England and Wales of sailors and soldiers, whether disabled or otherwise, on discharge from the Navy or Army, has presented an interim report recommending that as an experiment fifty men who have been discharged from the Navy or Army owing to disablement should be given a course of training in an agricultural college, with the view of obtaining for them permanent employment on the land, and, in the case of those proving specially capable, fitting them to become occupiers of small holdings. This recommendation has been approved by Lord Selborne, and endorsed by the War Office, and the Treasury has agreed to place funds at the disposal of the Board of Agriculture and Fisheries to defray the cost of the experiment. It is proposed that the men selected shall be sent to the Harper Adams Agricultural College, Newport, Salop, and to the College of Agriculture and Horticulture, Holmes Chapel, Cheshire, where they will be provided with board and lodging and be given a course of training in agriculture and horticulture free of charge to themselves. Any men who have been discharged from the Navy or Army on account of disablement, and desire to receive this course of training, should apply at once to the Secretary, Board of Agriculture and Fisheries, 4 Whitehall Place, S.W., for a form of application.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, October 11.—M. Ed. Perrier in the chair.—The President announced the deaths of Edouard Prillieux and Philippe Hatt, members of the academy.—L. **Lecornu**: The deformation of a cylindrical tube.—Henryk **Arctowski**: The solar faculæ. An account of a statistical study of Greenwich heliographic observations. From measurements of the areas of the spots and faculæ, the maximum for the latter is nine days behind the maximum for the spots. The author, from his researches on the Greenwich data, considers the phenomenon of the variation of the frequency of the sun-spots as being only a manifestation subordinate to the phenomenon of the variation of the faculæ.—Marcel **Brillouin**: Certain problems of mathematical physics in the case of hollow bodies.—Pierre **Lesage**: Salted plants and the transmission of acquired characters. Plants watered with salt water show differences, more or less marked, from plants of the same species watered with pure water. Starting with seeds of *Lepidium sativum* arising from plants watered with weak salt solutions in 1911, it is shown that some of the acquired characters are transmitted by the seeds, although the plants arising from the latter had been watered with soft water only.—E. **Demoussy**: The localisation of the acids and sugars in fruits. Various species of fruit, both ripe and partially ripe, were subjected to gradually increasing pressure, and the juices expressed collected in fractions and analysed separately. In some cases the amounts of acid and sugar vary considerably with the pressure. These variations are marked with apricots and grapes, small for peaches, and do not appear in strawberries and melons. The cause of this variation is discussed from the point of view of the osmotic pressures in the cells. The localisation of the dissolved matter in fruits is regarded as affording an explanation of the marked difference in the taste of certain fruits in the raw and cooked states.

BOOKS RECEIVED.

Continuous and Alternating Current Machinery Problems. By Prof. W. T. Ryan. Pp. 37. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 2*s*. 6*d*. net.

Practical Shop Mechanics and Mathematics. By J. F. Johnson. Pp. ix+130. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 4*s*. 6*d*. net.

Arithmetic for Carpenters and Builders. By Prof. R. B. Dale. Pp. ix+231. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 5*s*. 6*d*. net.

The Essentials of Descriptive Geometry. By Prof. F. G. Higbee. Pp. vi+204. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 7*s*. 9*d*. net.

Mortality Laws and Statistics. By R. Henderson. Pp. v+111. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 5s. 6d. net.

A Manual for Health Officers. By J. S. McNutt. Pp. x+650. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 12s. 6d. net.

Market Gardening. By F. L. Yeaw. Pp. vi+102. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 3s. 6d. net.

How to Lay Out Suburban Home Grounds. By H. J. Kellaway. Second edition. Pp. x+134. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 8s. 6d. net.

An Introduction to the Mechanics of Fluids. By Prof. E. H. Barton. Pp. xiv+249. (London: Longmans and Co.) 6s. net.

The Star Pocket-Book: or How to Find Your Way at Night by the Stars. By R. Weatherhead. Pp. 92. (London: Longmans and Co.) 1s. net.

The Surrey Hills. By F. E. Green. Pp. x+252. (London: Chatto and Windus.) 7s. 6d. net.

New Zealand. Department of Mines. N.Z. Geological Survey. Palæontological Bulletin, No. 3: Revision of the Tertiary Mollusca of New Zealand, based on Type Material. By H. Suter. Part ii. Pp. 69. (Wellington: J. Mackay.)

New Zealand. Department of Lands and Survey. Report on the Survey Operations for the Year 1914–15. By E. H. Wilmot. Pp. 78. (Wellington: J. Mackay.)

Board of Agriculture and Fisheries. Annual Report of the Education Branch on the Distribution of Grants for Agricultural Education and Research in the Year 1914–15. Pp. x+154. (London: H.M.S.O.; Wyman and Sons, Ltd.) 8½d.

Transactions of the London Natural History Society for the Year 1914. Pp. 85. (London: L. Reeve and Co., Ltd.) 3s.

Hill Birds of Scotland. By S. Gordon. Pp. xii+300. (London: E. Arnold.) 12s. 6d. net.

Earth-Lays: Geological and other Moods. By C. Tolly. Pp. 63. (London: J. M. Dent and Sons, Ltd.) 3s. 6d. net.

The War and New British Industries. Imperial Institute Monographs. Oil Seeds and Feeding Cakes, with a Preface by Dr. W. R. Dunstan. Pp. xxv+112. (London: J. Murray.) 2s. 6d. net.

Old London's Spas, Baths, and Wells. By Dr. S. Sunderland. Pp. xii+169. (London: John Bale, Ltd.) 7s. 6d. net.

The British Coal-Tar Industry: its Origin, Development, and Decline. Edited by Prof. W. M. Gardner. Pp. ix+437. (London: Williams and Norgate.) 10s. 6d. net.

The Antiquity of Man. By Prof. A. Keith. Pp. xx+519. (London: Williams and Norgate.) 10s. 6d. net.

Manuals of Chemical Technology. IV.: Chlorine and Chlorine Products. By Dr. G. Martin. Pp. viii+100. (London: Crosby Lockwood and Son.) 7s. 6d. net.

Iowa Geological Survey. Vol. xxiii. Annual Report, 1912, with Accompanying Papers. Pp. xliii+662. (Des Moines: Iowa Geological Survey.)

Annual Report of the Board of Regents of the Smithsonian Institution for the Year ending June 30, 1914. Pp. xi+729. (Washington: Government Printing Office.)

Smithsonian Institution. U.S. National Museum. Bulletin 91: Report on the Turton Collection of South African Marine Mollusks, with additional notes on other South African Shells contained in the U.S. National Museum. By P. Bartsch. Pp. xii+305. (Washington: Government Printing Office.)

DIARY OF SOCIETIES.

THURSDAY, OCTOBER 21.

INSTITUTION OF MINING AND METALLURGY, at 8.15.—The Geology of the Waihi Grand Junction Mine: Report upon Developments up to June 30, 1914: A. Jarman.

FRIDAY, OCTOBER 22.

PHYSICAL SOCIETY, at 5.—The Radiation and Convection from a Heated Wire in an Enclosure of Air: Dr. T. Barratt.—The Determinaton, by the Method of Diffusive Convection, of the Coefficient of Diffusion of a Salt Dissolved in Water: Dr. A. Griffiths.—The Magnitude of the Thermal Resistance Introduced at the Slightly Conical Junction of Two Solids, and its Variation with the Nature of the Surfaces in Contact: Dr. T. Barratt.

MONDAY, OCTOBER 25.

MEDICAL SOCIETY, at 8.30.—*Discussion:* Gunshot Wounds of the Peripheral Nerves. The Medical Aspect: Dr. W. Harris; the Surgical: W. Trotter.

TUESDAY, OCTOBER 26.

ZOOLOGICAL SOCIETY, at 5.30.—(1) The Distribution of Secondary Sexual Characters amongst Birds, with Relation to their Liability to the Attack of Enemies; (2) Some Observations on Pattern-blending with Reference to Obliterative Shading and Concealment of Outline: J. C. Mottram.—Fauna of West Australia. III. A New Nemertean—*Geonemertes dendyi*, sp. n.—being the First Recorded Land Nemertean from Western Australia. IV. *Palæmonetes australis*, sp. n., being the First Record of the Genus in Australia: Prof. W. J. Dakin.—A Collection of Mammals from the Coast and Islands of S.E. Siam, with an Account of the Fruit-Bats by Dr. Knud Andersen: C. Boden Kloss.—Studies on the Protozoan Parasites of the Fishes of the Georgian Bay: Dr. J. W. Mayor.—(1) A List of the Snakes of East Africa, North of the Zambesi and South of the Soudan and Somaliland, and of Nyassaland; (2) A List of the Snakes of North-East Africa, from the Tropic to the Soudan and Somaliland, including Socotra: Dr. G. A. Boulenger.—Some Notes upon the Anatomy of *Rana tigrina*: Dr. G. E. Nicholls.

FRIDAY, OCTOBER 29.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Thomas Hawksley Lecture: The World's Sources of Fuel and Motive Power: Dr. Dugald Clerk.

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THURSDAY, OCTOBER 28, 1915.

THE UNIVERSITIES AND WAR ECONOMY.

MUCH anxiety has been caused in the educational world by the circular of date July 28 from the Lords Commissioners of the Treasury to those universities and similar institutions in Great Britain which are in receipt of Government grants. In consequence partly of this circular, and partly of the general need for economy in the expenditure of public funds, a letter of date August 26 has been addressed to the joint secretaries of the Committee on Public Retrenchment by the Vice-Chancellors of the four northern universities (Leeds, Liverpool, Manchester, and Sheffield).

The danger which threatens our universities is the more imminent because the Treasury circular appears to take a quite reasonable view of the situation. In consequence of the loss of students due to their enlistment, the colleges have suffered from a serious reduction both in the size of the classes and in the income received from fees. To compensate for the latter loss special supplementary grants were given to them last year. It is pointed out by the Treasury authorities that if these special grants are to be continued throughout the war, however prolonged, and all the institutions so aided are to be allowed to remain open, however low the attendance of students may be, the burden on public funds—which would increase progressively as young men continue to enlist—might prove ultimately to be very great and out of all proportion to the educational benefits conferred on the community. Acting on this assumption, the circular foreshadows a possible very considerable reduction in the amount which Parliament is to be asked to vote in the future. It is suggested that savings might be effected not only by leaving all vacancies unfilled (we understand that the University of London is to remain without a Principal on this account), but also by temporary suspension of institutions, classes, departments, or hostels where the attendance falls below a certain level, the staff thus released being provided with suitably remunerated work of some other kind more directly useful in the present emergency. The colleges are also asked to submit an estimate of their probable expenditure and revenue, and to point out the directions in which they are able to effect further savings.

If the efficiency of universities could be measured by the number of students that they turn out, there might be a valid justification for the opinions expressed in the Treasury circular. But the war by which Germany now seeks to cripple Great Britain, and the successful war which Germany has been waging against our commerce for the last quarter of a century without opposition, have placed on our Universities a burden of national responsibility which cannot be measured by mere numbers of students. There has probably been no period in the history of our country when so great a demand existed for enterprise and activity in our universities as during the present national crisis.

The letter of the northern universities affords a conclusive reply to the Treasury circular. It is accompanied by a statement of the active work which the colleges have undertaken in connection with the war. This statement is of a confidential character, but it may here be safely stated without any risk of assisting the enemy that it includes practically every branch of pure and applied science. In addition statistics are given as to the numbers of staff and students serving with the colours or engaged in munition work.

It used to be said that England's battles were won on the playgrounds of the great public schools, and it is still true that these are largely responsible for the magnificent performance of our men in the trenches. But it is equally true that Germany's war against the allied European Powers has been waged in the laboratories of the German universities. It is now being recognised that this is a war of brains and science. It is sufficiently unfortunate if the supply of scientifically trained students be reduced at the present juncture, but it will be still more unfortunate if a check is placed on their future activities, which would probably have a permanent and cumulative effect on our national development. If England is to win this war, England must also be prepared to maintain a struggle for power, which will certainly not cease with the conclusion of hostilities. We have heard much talk about "silver bullets," but Germany's silver bullets have to a large extent been supplied by Great Britain in exchange for chemical and optical goods and dyestuffs.

The contingents of the Officers Training Corps of the northern universities have already contributed more than 1000 officers to the Forces, and similar contingents have been furnished by other modern universities. It has been abundantly shown by the statements received from past students that they have found their university training of the greatest possible value in the field. There can be no better preparation for the

exigencies of modern warfare than a first-year course in physics, chemistry, and mathematics, varied in some cases by medical and biological studies, and if this course can be followed by a second-year course including physical applications of the infinitesimal calculus, so much the better. It is true that we have military colleges, but the instruction in these would appear to be carried on by rule-of-thumb methods to a greater extent than in our universities, and therefore less calculated to produce the type of individual who can think and act in an emergency.

But all modern university colleges are largely attended by women, and with a growing demand for women's work in posts hitherto occupied by men, some increase in the numbers of these students may be anticipated. In any case, it would be a fatal misfortune if anything were done which could in any way interfere with this side of the university work.

Even if our colleges were entirely depleted of their students, there would still be grave objections to a proposal for disestablishing and disendowing them. The claims of the professor who lectures only six or eight hours a week and devotes the rest of his time to research are very well put forward by Prof. Grant Showerman in the *Popular Science Monthly* for June, 1915, in an article entitled "The Liberal Arts and Scientific Management." A professor may receive fourteen dollars for every hour that he is down to lecture in the time-table, but it is pointed out that his connection with his work never ceases throughout the day or the year, and when this is taken into account his princely salary reduces to about 1.2 dollars per hour for expert service in a profession requiring unusually protracted preparation and involving social relations with the best paid classes of the community.

As soon as lectures are over, the average professor devotes his attention to research, and not only does he receive no remuneration for this work, but he frequently pays the cost of apparatus or publishes books at his own expense. Not only in the northern universities, but also in nearly every other university in the kingdom, laboratories and college staffs have been generously placed at the disposal of the Government. While the nation is paying high wages for unskilled labour, it is not only paying nothing for assistance the value of which may be reckoned in millions, but it is even receiving income tax and other dues from the donors at a rate calculated in many cases to place considerable anxiety on their shoulders.

The reason why the college professor engages in research, even at the risk of stinting himself and family in the necessities of life, is that he cannot help himself. He has an object to perform, and his happiness depends mainly on its accomplishment. It is certain that a falling off, should such occur, in the amount of class work would lead to an increased amount of research at a time when that research is urgently needed by the Government—more urgently needed than the Government or any similar body can possibly appreciate. Not only are mathematics, physics, and chemistry needed in connection with such varied applications as aeroplanes, wireless telegraphy, poisonous gases, periscopes, and explosives, but entomology, leather-making, economics, modern languages, botany, law, and history all have their uses in connection with the war.

The suggestion that certain members of the college staffs should be released and that they should be asked to find temporary paid work elsewhere, is one that ought only to be carried out with extreme caution. At the present time many professors and lecturers have undertaken temporary military or other duties, and the colleges are already effecting savings by the amounts of the salaries thus set free. It would thus appear that the system has already been adopted on a voluntary basis by the college staffs themselves. It is not evident from the circular whether, and if so how far, the Treasury contemplates the possibility of exercising pressure in the same direction, but we should be sorry to think that it has any desire to do so. Such an attempt would necessarily involve one of two alternatives, either "putting a round man into a square hole"—in which case good-bye to all the usefulness of his work, perhaps an irreparable loss to the community—or payment for research.

Now it would undoubtedly be of great advantage that persons engaged in valuable investigations should receive some compensation for the loss of income they may incur in carrying on the work. But it would be quite impossible for any Government at the present time to carry through any scheme which Labour leaders would distort into a proposal to put money into the pockets of the "idle rich." Even if this difficulty were overcome, payment for research would be sure to be made conditional on a clear statement being made as to the results aimed at and the practical uses to which they were to be applied. Now the main essence of research is that something has to be found out, the result of which is unknown, and it cannot be possibly anticipated at the outset what practical applications may arise. Any

attempt to place this work under a system of Government control and inspection would involve the exclusion of the important class of investigations which leads to the most novel and far-reaching results.

Our universities are straining their resources to the utmost in the effort to keep down expenditure. Where members of their staffs have gone on active service (in some departments to the extent of above fifty per cent.) their work is being cheerfully taken over by their colleagues. Not only are building operations being suspended (and this is probably a wise precaution for many reasons), but the purchase of books and apparatus is being reduced to the bare minimum.

The extra work undertaken by the remaining members of the staffs is only reduced in a very slight degree by the falling off in students. So long as a certain number of *classes* have to be held, a difference in the numbers of each class does not make a great difference in the work. The strain is bound to make itself felt sooner or later. But there are noticeable cases in which the effort to secure economy appears to have been carried too far. It cannot be desirable in the public interest that vacancies in two such important departments as physics and chemistry should remain unfilled, and we believe that it is in the interests of the Government, instead of bringing pressure on the universities to effect further economies, rather to exert its influence in checking them from going too far.

The four Vice-Chancellors of the northern universities are to be congratulated on the strong case they have made out. The matter is, however, one which affects all the modern institutions of university rank, and several of the statements in this article have been derived from independent sources. We hope that the action which is now being taken will prevent a mistake being made which must inevitably lead, sooner or later, to the realisation of the ideals of German militarism at the expense of Great Britain.

OLD-FASHIONED NATURAL HISTORY AND NEW-FASHIONED BOTANY.

(1) *The Hundred Best Animals.* By Lilian Gask. Pp. 304. (London: G. G. Harrap and Co., 1914.) Price 7*s.* 6*d.* net.

(2) *True Stories about Horses.* By Lilian Gask. Pp. 266. (London: G. G. Harrap and Co., n.d.) Price 3*s.* 6*d.* net.

(3) *The Human Side of Plants.* By Royal Dixon. Pp. xix + 201. (London: Grant Richards, Ltd., 1915.) Price 7*s.* 6*d.* net.

(1) THE stories of a hundred animals of distinction are told to two children by a veteran who had been a mighty hunter in his day, and good stories they are. He talked mostly about mammals—lion and tiger, seal and walrus, elephant and ape, camel and llama, antelope and deer, sloth and ant-eater, kangaroo and duckbill. But, like Solomon, the veteran spake also, in the last five of the twenty-nine chapters, "of fowl, and of creeping things, and of fishes." We are not sure that Solomon would always have agreed with him; for instance, about the water reservoirs in the camel's stomach; or as to the advisability of telling children that wise folk think the tallest animal in the world has lengthened out its neck by so much reaching; or that "squirts out" is the right word to use in regard to the exudation of toad's poison. But there is no doubt that the book is one which children will thoroughly enjoy and also profit by.

The talks are natural, interesting, instructive, with fresh news to tell, and with no tiresome "writing down." Just now and again the old Nimrod nods a little; for instance, on the last page when he says, in a way quite unlike himself: "We come to understand the highest examples of the different animals—call them best if you will—by comparing them with others of the same species below them in the scale, whether of physical strength and beauty or intelligence." He was also nodding when he said that the heron "is very scare in England now." But these are trivial matters; the important fact is that this is a thoroughly sound and successful book to be cordially recommended. It is adorned and illumined by a hundred excellent illustrations—often strikingly alive—from original photographs by A. F. W. Vogt.

(2) The second book from the same pen is also intended for young readers. It contains many well-told true stories about horses. We are told of the doctor's horse that defended its sleeping master; of the horse that fought and defeated the wolves it had been left to satiate; of an Arabian horse that twice saved a soldier's life; of a number of mares, some past foaling, which combined for six hours to lift the foals above the level of a flood; of a Shetland pony that saved a child from drowning; of a horse that kept a long vigil over a dead soldier; of another that lifted a little child out of harm's way, and of many more besides. As will be seen from the examples cited, the stories are of a homely, old-fashioned type, and we

are not surprised to find no reference to the "thinking horses" of Elberfeld. There are effective illustrations, and the printing of both books is such as suits both young and old eyes.

(3) Mr. Dixon has the courage of his anthropomorphism, which is of the deepest dye. For he maintains that plants "see, hear, taste, feel, walk, swim, run, fly, jump, skip, hop, roll, tumble, set traps, and catch fish; decorate themselves that they may attract attention; powder their faces; imitate birds, animals, serpents, stones; play hide and seek; blossom underground; protect their children, and send them forth into the world prepared to care for themselves—indeed, do all those things which we ourselves do. We now know that plants have even minds and souls, with which to think and to worship."

This is partly a rebound from a *hortus siccus* botany, partly an uncritical vitalism, and partly a somewhat saddening illustration of the lack of critical balance. Saddening, we call it, because the author has a fine series of most interesting facts to set forth concerning the intense vitality of plants, their movements, their sensitiveness, their adaptations, and their purposiveness (we do not say purposefulness), and yet he has gone and queered his pitch with an intolerably anthropomorphic and sentimental phrasing.

No one can be very enthusiastic over the botanist's terminology of chemotaxis, heliotropism, nyctinastic movements, and the like, but there should be some middle way between this and talking, as Mr. Dixon does, about the activities of plants as if they were on a plane with our own. We do not blame the author for regarding plants as psycho-physical beings—which seems to us a position which can offer a strong defence—nor even for speaking, if he wishes, about their senses (seven in number) and experiments, their "mentality and spirituality"; we blame him for leading the unwary to think that plants tackle the business of life on anything like human lines. For this will have to be unlearnt. Theirs is certainly *another way*, even farther from our understanding than instinct is.

TEXT-BOOKS OF PHYSICS.

(1) *Elements of Optics for the Use of Schools and Colleges*. By G. W. Parker. Pp. iv+122. (London: Longmans, Green and Co., 1915.) Price 2*s*. 6*d*.

(2) *Elementary Experimental Statics*. By I. B. Hart. Pp. vii+200. (London and Toronto: J. M. Dent and Sons, Ltd., 1915.) Price 2*s*. 6*d*.

(3) *Introduction to Heat*. By A. R. Laws and P. W. Todd. Pp. x+212. (London: Mills and Boon, Ltd., 1915.) Price 2*s*. 6*d*.

(4) *Experimental Harmonic Motion: a Manual for the Laboratory*. By Dr. F. G. C. Searle. Pp. x+92. (Cambridge: At the University Press, 1915.) Price 4*s*. 6*d*. net.

(1) IN Mr. Parker's "Elements of Optics" the subjects of reflection, refraction, mirrors and lenses, simple optical instruments, and dispersion are dealt with in four chapters. The book is intended for beginners, and no further mathematical knowledge is required for its perusal than an acquaintance with elementary geometry, simple algebraic equations, and the trigonometrical ratios. The text consists chiefly in the derivation of the usual formulæ of geometrical optics, the deviation method being employed for mirrors and lenses. The statements are accurate and concise, and the diagrams clear. Many teachers will regard the book as being too sparse and somewhat uninteresting owing to the absence of experimental matter. The inclusion of experiments to verify the laws and results by the aid of simple and inexpensive apparatus, would have enhanced the value of the book considerably. Numerical exercises are interspersed in the text, and answers are supplied.

(2) "Elementary Experimental Statics," by Mr. Ivor B. Hart, is written for pupils beginning the subject of mechanics. The mathematical knowledge assumed does not extend beyond an acquaintance with simple algebraic equations. The author deals with parallel forces, centres of gravity, inclined forces, friction, and the simple machines. The chief elementary facts are impressed on the pupil by a series of simple experiments. Full directions for the performance of these experiments are given, and the method of recording the results is indicated. It is better to insist on the tabulation of actual observations than results obtained after a mental calculation, as in col. 5 of the table on p. 45. The book is provided with a large number of questions and numerical exercises. The pupil who performs the experiments and works the examples in this book will have laid a good foundation for further study in experimental science.

(3) "Introduction to Heat," by Messrs. Laws and Todd, may be used both as a class and laboratory text-book in schools. The aim of the authors has been to introduce many phenomena from everyday life, and by appealing to the ordinary experiences of the pupil to awaken an intelligent interest in the subject. The order of treatment is somewhat different from that usually adopted in text-books of this character. The opening chapter

deals with conduction and convection of heat, and this is possible because at such a stage only a descriptive treatment of these subjects can be attempted. Other sections of the book deal with the barometer and thermometer, expansion, evaporation and condensation, hygrometry, fusion and solidification, specific heat, radiation, heat and work. Certain paragraphs are to be omitted on first reading.

Speaking generally, the authors have succeeded in producing an interesting text-book, but in many places the statements are loose and not characterised by that precision of language which it is so essential to inculcate in the mind of a beginner. Thus on p. 19 the authors speak of the pressure due to 60 c.c. of water, and on p. 88 define the British unit of heat as "the quantity of heat required to raise 1 lb. of water 1° F." This omission of "the temperature of" is a common occurrence in the text. Again on p. 20 we have an experiment "To determine how much 1 c.c. of air expands when heated." In this the temperature of 160 c.c. of air is raised from 15° C. to 85° C., the amount of expansion being 40 c.c. The calculated expansion of 1 c.c. is $40/(160 \times 70) = 1/280$. The authors then state: "an accurate and at the same time convenient result is 1/273." On p. 140 paraffin-wax is not a suitable material to illustrate melting point by the curve of cooling. In the diagram on p. 40 the pressure gauge should be connected to the inner cylinder of the hypsometer. The book contains a large number of questions and numerical exercises.

(4) Dr. Searle's "Experimental Harmonic Motion" is written on lines very similar to his well-known manual on "Experimental Elasticity." The subject-matter dealt with, however, is not so wide as the title would seem to imply. The first part of the book is devoted to the elementary theory of harmonic motion, and is apparently carried only so far as is necessary to understand the experiments described in the second chapter. There is no discussion of damped vibrations, composition of harmonic motions, or the analysis of periodic curves. The experiments described in the second chapter (fourteen in number) are such as are performed in the author's classes at the Cavendish Laboratory. They include oscillation methods for comparing moments of inertia, determinations of the acceleration due to gravity, the experimental study of a pendulum with yielding support, and an investigation of a system with two degrees of freedom. A theoretical discussion of each experiment is given, and there are full practical details for the design of the apparatus to ensure satisfactory results. Each experiment is furnished with a typical series of data obtained in an actual experiment. The exposition is clear, and the book may be profitably read by university students. Many teachers will welcome a book of this kind on account of the precise details for the setting up of the various experiments.

LABORATORY WORK ON COAL AND COAL-PRODUCTS.

Laboratory Work for Coal-mining Students. By J. Sim and A. M. Wylie. Pp. viii+136. (London: E. Arnold, 1915.) Price 2*s*. 6*d*. net.

THE difficulties associated with coal analysis are determined in part by the fact that a material which is consumed in tons has for convenience of manipulation to be tested in grams, and in part by the variety of uses to which coal is applied. The first necessitates merely extreme care and method in sampling, but the second requires a diversity of tests demanding the greatest skill and experience. The most satisfactory way of conducting a test is obviously to submit a large sample of the material to the special process to which it is subsequently to be applied. This is frequently done; but it is not described in the present volume, which is concerned with laboratory methods only.

The difficulties attending coal analysis may be realised when one considers the variety in composition as well as the chemical sensitiveness of the substance. Coal is no sooner exposed to the air than it begins, especially when in powder, to absorb oxygen and to evolve carbon monoxide and dioxide. The sulphur which is present, partly as organic sulphur and partly as pyrites, also undergoes oxidation. Then, again, the nature of the products and by-products, upon which its value in the gas and coking industry depends, is determined by the character of the coal as well as by the temperature at which these products are extracted or distilled. For example, it has been shown recently that extraction with pyridine removes considerable quantities of paraffins, that distillation *in vacuo* gives rise to a series of naphthenes (cycloparaffins), whilst ordinary destructive distillation at high temperatures produces the coal-tar hydrocarbons. It would appear from this that the original hydrocarbon of the coal passes through various stages in the process of heating. Finally, a knowledge of the thermal value of the coal when used as fuel is essential. It will be seen that the investigation of a sample of coal is not a simple affair.

The present volume has been written with the object of facilitating the laboratory work of a coal-mining student, that is, one who is studying the scientific basis of the industry from every point

of view. It is divided into five chapters, the first two being concerned with the coal itself, the second two with the products, namely, oil tests and gas analysis, and the final chapter with fan and ventilation tests.

The volume has evidently been put together with great care by its authors, who have had practical experience of their subject. The description of the apparatus and methods is clear and concise, and illustrated by diagrams and by actual examples, so that the student should have no difficulty in carrying out the different operations. J. B. C.

OUR BOOKSHELF.

Some Frontiers of To-morrow: An Aspiration for Europe. By Prof. L. W. Lyde. Pp. viii + 120. (London: A. and C. Black, Ltd., 1915.) Price 2s. 6d.

IN this small volume Prof. Lyde makes suggestions for the settlement of European frontiers after the war. Three considerations are laid down as of vital importance: (1) that the frontier should be associated, not with war, but with peace; (2) that the unit of area should have some direct relation to national sentiment; (3) that inability to assimilate should disqualify any Power for territorial expansion. The first suggestion is the most important. Prof. Lyde maintains that frontiers should be identified with features related to the meeting of people in the ordinary routine of peaceful intercourse. If this be true, it follows that a navigable river makes the best frontier. A defensive frontier—the type of frontier of the past—will never put an end to conflict between neighbours, but may even promote it. An inhabited, in contrast to an uninhabited, frontier belt encourages contact between adjoining people, discourages racial and cultural antagonism, and so minimises the chance of friction, and promotes civilisation. Prof. Lyde is always stimulating, even if he fails to convince at times. His book is crammed with ideas from beginning to end, which should attract the attention of statesmen. But it will be hard to convince those who have treaty making in their hands that accurate scientific knowledge is a real asset in the matter, and that the geographer is the expert who has the knowledge and should be consulted.

R. N. R. B.

Liverpool Marine Biology Committee. L.M.B.C. Memoirs on Typical British Marine Plants and Animals. Edited by Prof. W. A. Herdman. xxiii. Tubifex. By G. C. Dixon. Pp. viii + 100 + 7 plates. (London: Williams and Norgate, 1915.) Price 3s. 6d.

Tubifex rivulorum is a slender Oligochæte, not more than two inches long, often found in large numbers in the mud of rivers and streams, but it occurs frequently also in brackish tidal waters, and therefore a memoir on this worm is appropriately included in a series dealing with marine animals. Of the aquatic Oligochætes, Tubifex is the type usually chosen for study in advanced classes in this country. Accounts of the different systems of organs have appeared in various zoological publications, but for figures of the worm the student has hitherto been dependent chiefly on the memoirs of d'Udekem (1855) and Vejdovsky (1884). Miss Dixon has revised and extended the previous accounts, with the result that her memoir gives a careful and reasonably full description of the structure of the worm, illustrated by seven well-drawn plates, of which the first in particular will be useful to the student.

After a few general remarks on the habits of the worm, an account is given of the external features and of the various systems of organs, the hermaphrodite reproductive apparatus being described in considerable detail, almost one-half of the memoir being devoted to this group of organs. Of considerable interest is the discovery that Tubifex possesses dimorphic spermatozoa. Both kinds of spermatozoa are of the elongate type and are tailed, but they differ in size and in the proportions of their parts. In the ordinary spermatozoa the head forms about one-sixth of the total length. The second type of sperm is about three times as long as the ordinary one, and the head forms about one-half the total length.

A good account is given of the remarkable spermatophores of Tubifex, which are moulded into their characteristic form in the spermathecal duct.

The memoir concludes with a brief reference to the parasites of Tubifex and a bibliography.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Distances at which Sounds of Heavy Gun-firing are Heard.

REFERRING to the correspondence on this subject, I have been collecting information as to places at which the sound of the firing in Belgium has been heard in this country.

I have undoubted records of its having been heard at many places throughout the south-east of England (all of them in Essex, Kent, Sussex, or Surrey), and am giving the result of my inquiries in a paper to be read before the Essex Field Club on October 30. Here, at a distance of about 125 miles from Ypres (taking that town for convenience, as a known centre), I have heard firing quite unmistakably since the beginning of the war—often all day, and for many days in succession, and frequently at night too.

So far as I have been able to ascertain, the greatest distance from Ypres at which the firing has been heard unmistakably is about 140 miles, though I have a less satisfactory record up to 150 miles. No doubt, however, it has been heard further in favourable conditions. Observations seem to show that the direction of the wind has less to do with the transmission of the sound than certain atmospheric conditions, though it is not easy to ascertain exactly what these conditions are.

My house here stands in a fairly open and elevated position, about 155 ft. O.D., with no higher ground in the immediate vicinity, or between me and Ypres. Many of my neighbours, who live in similar situations, also hear the sound, and recognise clearly what it is. It seems much less audible at lower elevations, and quite inaudible among houses. For instance, I cannot hear of its ever having been heard in the adjacent town of Chelmsford, or in any part of London.

MILLER CHRISTY.

Broom Wood Lodge, Chignal St. James,
Chelmsford, October 19.

The Cumberland Earthquake of October 2.

I WAS interested to read the note in NATURE of October 21 (p. 208) referring to an earthquake in the Lake District, Cumberland, on October 2, at 3.15 a.m. My wife and I spent some weeks at Seatoller, Borrowdale, leaving on October 2. Early in the morning of that day we were awakened by a strange noise and the house vibrating. The noise and vibration were so completely similar to what occurs in my own house when the hot-water boiler is overheated and steam, condensing in the pipes, causes "hammering," that I was on the point of getting up to turn on the bathroom tap, when it ceased. As we were leaving in the morning the proprietors inquired if we had heard the noise in the night, and I replied at once that I had heard the hammering in the pipes of the hot-water system, but was told that it was quite impossible for the water to have been hot at the time. I had no idea of the true explanation until I read the note referred to. Seatoller is about 30 miles S.S.W. of Carlisle and 4½ miles N.N.E. of Scafell Pike. Possibly it may be of interest to record that at this place the earthquake was accompanied by concussions and vibrations sufficient to waken the inhabitants.

FREDERICK SODDY.

October 23.

The Etymology of "Chincough."

WHOOPING-COUGH is, or used to be, called in the south of Scotland, "chincough," but the "ch" was hard, so that it sounded kincough, or kink-cough. In Jamieson's Scottish Dictionary the word "kink" has the meanings (1) a violent fit of coughing attended with suspension of breathing, (2) a regular fit of the chincough. "To kink" is to labour for breath in a severe fit of coughing. The more purely Scottish word for whooping-cough is "kinkhost," in the Belgic language *kink-hoest*.

L. B.

October 23.

THERE can, I think, be no doubt that "chincough" is a good English word, meaning whooping-cough and nothing else. It has nothing to do with *chien* (a dog), as Mr. Hart supposes (NATURE, October 21), or with chin, although to anyone who has noticed the depression and thrusting forward of the lower jaw during a paroxysm this derivation might seem probable. The word is, according to Skeat, properly chink-cough, and in Scotland and some parts of England a paroxysm is called a kink, which, again according to Skeat, means a catch in the breath, from kik, or kuk, to gasp, an imitative word, which is also the base of cough. The term kinkhost, still in use in Scotland, resembles the German equivalent, *keuchhusten*, which is also imitative. The French *coqueluche* is more puzzling, but probably has reference to the crowing inspiration which follows the expiratory spasm.

DAWSON WILLIAMS.

London, October 22.

As your correspondent (NATURE, October 21) points out, chincough has certainly nothing to do with "hiccough"; but has it anything to do with the French *chien* = a dog, as he supposes? Chincough is the softer English equivalent of the Scotch kink-host (Dutch, *kink-hoest*). Besides, the noun there is also the verb, to kink (O. Dutch, *kinken* = to cough), and even an Englishwoman, at least in the north, who calls the disease whooping-cough, will tell one when her child began to "kink" with its cough. My dictionary compares the word with the Anglo-Saxon "cincung" = a fit of laughter, and kink is sometimes also used in that sense, or in connection with any choking inspiratory spasm. Finally, there is nothing in the sound of whooping-cough to suggest a dog, though the cough of croup might do so.

M. D.

Longitudes of Two Markings on Jupiter.

IN NATURE of October 14 the longitudes of the S. Tropical Disturbance and the Red Spot which I gave should be in each case minus 75·14°, if they are to correspond with the adopted period of System II. :—

S. Tropical Disturbance			Red Spot Hollow		
Date 1915	P. end	f. end	Date 1915	P. shoulder	f. shoulder
Sept. 11	313·1°	—	Sept. 10	—	185·1°
13	310·8°	—	12	149·5°	—
20	308·4°	—	17	149·1°	186·0°
21	—	42·6°	19	148·9°	187·6°
26	—	37·7°	27	—	185·1°
28	—	36·5°	29	—	185·1°
30	305·3°	35·3°			
Oct. 1	—	34·6°			

SCRIVEN BOLTON.

CHINESE DEFENSIVE ARMOUR.[1]

THE somewhat ponderous title of the work before us rather obscures the subject of this monograph, which is upon the origin and history of defensive armour, a theme of considerable cultural importance and here treated systematically for the first time. As a result, we have a masterly description of Oriental protective armour, and suggestive fresh light is also thrown upon certain sources of early Chinese civilisation.

The research is based primarily upon a large collection of ancient Chinese clay figures dug up (apparently by the author) from graves in the provinces of Shen-si and Ho-nan during the years 1908–1910, and deposited among the rich collections from the Far East now in the Field Museum of Natural History at Chicago, of which the author is a well-known curator and field-explorer.

The hides of the archaic Chinese cuirasses of the pre-metal age are ascribed by ancient tradition to two animals named respectively *Se* and *Si*, which are identified by the majority of sinologists with one or two species of rhinoceros. Dr. Laufer, who combines with his scientific physical training also a scholarly knowledge of Chinese, revises the Chinese texts at first hand, and appears to substantiate his identification of the *Se* as the single-horned and the *Si* as the two-horned Sumatran rhinoceros. In addition to the mass of mythological and folk-lore references to

[1] "Chinese Clay Figures." Part i., Prolegomena on the History of Defensive Armour. By B. Laufer. Field Museum of Natural History Publication 177, Anthropological Series, vol. xiii., No. 2. Pp. 69–315+64 plates. (Chicago: Field Museum of Natural History, 1914.)

these animals extracted from ancient literature and art, Dr. Laufer has elicited historical references to these animals, as royal presents and otherwise, in the official annals, which are important as indicating some chronology for the former geographical range of these animals in northern China and central Asia, where they have long been extinct. It appears that the two-horned (or Sumatran?) rhinoceros no longer existed within China proper in the first century A.D., and was only to be found to the south of the Yangtse; while the one-horned species survived in China in the Upper Yangtse valley down to the Middle Ages. In connection with the former range of these animals we would suggest that the Arabic name "*Kargadan*" is obviously cognate with the Indian title for the rhinoceros, which in the Sanskrit is "*Khadga*," which means literally "the cutter," or "sword," evidently with reference to the horn.

Fig. 1.—Eskimo armour of ivory plates and fragment of iron plates. From "Chinese Clay Figures."

The association of the rhinoceros with the myth of the unicorn is examined in great detail; also the mystic use of the horn as anti-poison goblets up to the present day in China. It appears to us possible that this latter use was derived from India, or at least through false etymology by confusing the Sanskrit name for "horn," namely *Vishāna*, with the Sanskrit word for "poison," namely, *Visha*; for the Chinese are known to have called the rhinoceros-horn in the eleventh century A.D. by the name *pi-sha-na* (Wylie, "Notes," 195), their version of the Sanskrit word. This false etymology would also readily lend itself to the astrological view that the horn of the rhinoceros symbolised the ascending node, and as such represents hostility to the powers of darkness, and as a poison-destroyer. In this regard it is perhaps noteworthy that there seems to us a suggestion of purity also (or is it phallic?) in respect to the armorial unicorn, which, according to the legend, was only to be caught at the lap of a

Fig. 2.—The animal "*Si* resembling swine" (from the illustrated edition of *Erh ya*). From "Chinese Clay Figures."

virgin maid. It is clear, however, that Pliny ("Nat. Hist.," 8, 21), who must have been

familiar with the rhinoceros in the circus, did not identify it with his fierce *mono-ceros* or unicorn.

In connection with the use of rhinoceros hide as armour, it is recalled that it is only when the skin is dried and properly prepared that it becomes of iron-like hardness; for the skin of the living animal, notwithstanding popular hunters' tales to the contrary, is quite soft and can be readily penetrated in any place by a bullet or easily pierced by a hunting knife.

We have not space here to follow the author in his exhaustive account of the origin and development of defensive armour. He treats of this in long chapters devoted to "Defensive Armour of the Archaic Period" (B.C. 1122–255), characterised by hide cuirass and scale armour in which metal was absent; "Defensive Armour of the Han Period" (beginning in the third century B.C.), when metal (at first copper and latterly iron) scales were introduced, from Persia, Dr. Laufer believes, to form "plate" armour; "Chain and Ring Mail," also from Persia, though this was confined to the Arabs and Moghuls and Tibetans, and never adopted by the Chinese; "Plate" armour, which was much more ancient and at first formed of bone-plates; "Sheet" armour, as in the medieval West, first came into use in China in the Tang period (A.D. 618–906), and from India, the author seems to believe. A chapter is also devoted to "Horse-Armour," shedding much new light upon this interesting phase of protective armament.

A word of high praise must also be given to the illustrations, which are well chosen and significant; and the photographic plates, sixty-four in number, are beautifully reproduced.

L. A. WADDELL.

MODERN BULLETS IN WAR AND SPORT.

FOUR interesting articles appeared in the columns of *Engineering* in August of this year, contributed by Fleet-Surgeon C. Marsh Beadnell, and these have now been reprinted in the form of a thin pamphlet. The articles are full of information as to the weights and velocities of different bullets and as to the effects of bullets of different kinds when they strike various substances at different points in their trajectory. The great experience of the author as a big-game sportsman on the one hand and as having seen many cases in the South African and Philippine wars and the present war on the other give great value to his observations on the destructive or at times very slight effects produced by the modern bullet; his treatment of the dynamical and especially of the aërodynamical principles affecting the motion of projectiles is less satisfactory.

In dealing with the effects of bullets the author shows how the damage done depends on the energy lost by the bullet; how, for example, a bullet at a high velocity and striking properly end-on may drill a clean hole, doing the minimum of damage and losing but little of its velocity, while at a later stage of its flight when travelling more slowly, and especially if in any degree inclined to its trajectory, the destruction is incomparably greater, and the loss of energy as represented by v^2 equally so.

The following experiment will exemplify this fact:—Two skulls were filled with a substance of a consistency as near as possible to that of the brain. Against the one was fired a normal bullet at high velocity, against the other a similar bullet at low velocity, this being effected by using a quarter charge; the range in each case was 10 ft. The first skull was neatly perforated, and the bullet, unaltered in shape, was found embedded 26 in. in the wood backing; the second skull was partly disarticulated, and was fractured posteriorly, the bullet lying inside against its posterior wall. In the case of the first skull the bullet parted with but little of its energy, and that only at the actual points of entry and emergence. In the case of the second skull more of the bullet's energy, both absolutely and relatively, was expended on it and its contents.

In an experiment of this sort a good deal depends on the compressibility of the material filling the envelope. As illustrating this point it may be permitted to refer to an experiment made by the writer of this notice at the time that he was photographing bullets. In order to ascertain if it would be practicable to photograph a bullet glancing off still water, he constructed a long trough of thin wood open at the top, somewhere about 3 ft. long and 4 or 5 in. wide and deep, and on to the water in this he fired a 0·303 bullet at as near a grazing incidence as he could. The water was hit about two-thirds along the trough, and was driven out as by an explosion. The front and sides of the trough in advance of the point of striking were split into matchwood, and generally, apart from the photographic difficulties, it seemed desirable to experiment in other directions.

The author has experimented on the inclination at which the modern high-speed bullet will penetrate a skull, and found that at angles above 5° or 6° he obtained penetration, whereas Snider and Martini bullets would glance off at much greater angles. Space does not allow of reference to the numerous valuable observations of the author on the curious effects of bullets both in big game and in warfare. These will be read with the greatest interest. It is not possible, however, to follow the author in his excursions in the domain of pure dynamics, and his treatment of the action of the air on the projectile appears to the writer to be very largely imaginary and incorrect. So difficult a subject as the action of air upon a rotating projectile, whether spherical or elongated, and whether the axis of spin is in or across the trajectory, scarcely admits of any but the most rigid treatment, and in this the author might find Mr. Crabtree's admirable book illuminating. There is a statement which is new to the present writer, and it would have been well to have given the authority.

Thus, up to speeds of 790 ft. per second resistance varies as the square of the speed, between 790 and 990 ft. per second as the cube, between 990 and 1120 ft. per second as the sixth power, between 1120 and 1330 ft. per second again as the cube, and above 1330 ft. per second again as the square of the speed; above 1500 ft. per second the relationship is not known.

C. V. BOYS.

PROF. VIVIAN B. LEWES.

WE much regret to see the announcement that Prof. Vivian B. Lewes died on October 23, of pneumonia, at Mold, Flintshire, where he was to deliver one of a series of Gilchrist Lectures on explosives.

Prof. Lewes was born in 1852. His education was undertaken by his uncle, George Henry Lewes, the well-known author of the "History of Philosophy" and other works. On leaving University College School at the age of sixteen, he became assistant to Dr. F. S. Barff, and in 1870 to Prof. A. W. Williamson at University College. Later he worked under Dr. C. Graham at the Birkbeck Institute, and was appointed assistant at the Royal Naval College, Greenwich, in 1879, where he succeeded Dr. H. Debus as professor of chemistry in 1888, which post he resigned a year ago. He was appointed chief superintending gas examiner to the corporation of the City of London in 1892, and at the time of his death was chairman of the Chemical Section of the Munitions Inventions panel.

His chief scientific work was on the action of heat on hydrocarbons and the cause of luminosity of flames; papers on these subjects were published in the Proceedings of the Royal Society in 1893–1895. Lewes's acetylene theory of luminosity, whilst it has met with much criticism, has been accepted widely as the correct explanation of the main interactions giving rise to luminosity. He was also the author of papers on pentathionates.

When, in 1892, Willson, in Canada, first obtained calcium carbide on a commercial scale, a sample was forwarded to Lewes, who, at the Royal Society of Arts, in 1894, brought this substance under the notice of an English audience. Later he did much to establish the success of the new industry. No one, indeed, was more welcome or more certain of an appreciative audience at the Society of Arts, and there he delivered several series of Cantor and other courses of lectures, dealing with such subjects as coal gas, explosives, liquid fuel, etc.

As a lecturer under the Gilchrist Educational Trust he was most popular and widely known throughout the country. He was, indeed, the last of the original group of Gilchrist lecturers, the panel of which included many illustrious names.

Prof. Lewes did excellent pioneer work in connection with the University Extension lecture scheme and as a lecturer for the Technical Education Committee of the London County Council. This was the work largely of a past decade, but filled a most important place in our educational system. He laid claim justly to have instilled the desire for further chemical knowledge in numbers of young students, and contributed very greatly to the success of systematic chemistry courses in our numerous technical schools and institutions.

His connection with the Navy was naturally not without its influence on his researches, many of which formed the subject of communications to the Institution of Naval Architects (of which he was a vice-president). The institution awarded him its first gold medal for a paper on "The Formation of Boiler Incrustations and Oily Deposits." Other important papers were on the corrosion of metals, anti-fouling compositions, and the spontaneous ignition of coal.

Prof. Lewes's principal technical field, however, was in connection with coal gas. He was always a welcome lecturer at the Institute of Gas Engineers and other similar societies, before the members of which he dealt in a lucid manner with current problems affecting this important industry. He was the author of several books, including "Acetylene," which is a standard work of reference, "Service Chemistry," now in its fourth edition, "Liquid and Gaseous Fuel," and "The Carbonisation of Coal."

Prof. Lewes's genial personality, his kindly and generous nature, endeared him to a very wide circle, both of personal and professional friends. Among the large number of naval officers with whom his duties brought him in contact no one was more popular or more respected.

NOTES.

WE much regret to announce the death, on October 23, from heart failure following influenza, at fifty-one years of age, of Dr. R. Assheton, F.R.S., University lecturer in animal embryology at Cambridge since 1911.

WE regret to announce that Sir Andrew Noble, Bart., K.C.B., F.R.S., to whose scientific work on artillery and explosives the marvellous developments of heavy weapons within the last fifty years are chiefly due, died on October 22, at eighty-four years of age.

MR. W. MARRIOTT has retired from the post of assistant secretary of the Royal Meteorological Society held by him for the last forty years, and has been succeeded by Mr. A. H. Brown, the chief clerk of the society.

MR. W. K. CARR, the owner of one of the best-equipped private laboratories in the United States, died recently at his home in Washington, at the age of fifty-five. On leaving the University of Virginia in 1878, he spent twelve years in the sale and manufacture of cotton at Norfolk, Va. Since then he had devoted most of his time to scientific research.

THE death is announced, in his sixty-fifth year, of Mr. C. F. Holder, of Pasadena, the writer of a large number of books on the natural history of southern California. He was educated at the Friends' School, Providence, R.I., and at the United States Naval Academy. For a few years he was an assistant at the American Museum of Natural History, New York. Mr. Holder's special interests were in marine zoology.

THE first meeting of the new session of the Geological Society will be held on Wednesday next, November 3, at 5.30 p.m., when Dr. C. W. Andrews will exhibit photographs and give an account of the

discovery of a fossil elephant at Chatham. Owing to the possibility of air-raids over the metropolis, and the consequent disorganisation of traffic, the council has decided that the time of the evening meetings shall be changed temporarily from 8 p.m. to 5.30 p.m.

WE regret to record the death of Lieut. J. Gordon Hollingsworth, of the 10th Battalion of the Middlesex Regiment, who was killed in the Gallipoli Peninsula on August 12. He was the second and only surviving son of Mr. A. T. Hollingsworth, one of the managing directors of *Engineering*. He was reported "missing" some weeks ago, and it was only on October 15 that official announcement was made that he fell gallantly leading his men in an advance which took place soon after the landing at Sulva Bay. He was educated as an engineer, and joined the staff of our contemporary, being later elected a director of *Engineering*, Ltd.

IN a review of Dr. E. Hindle's book on "Flies in Relation to Disease," published in *Science* for July 16, the remark was made that the author had been killed in Africa. Referring to this statement, Prof. G. H. F. Nuttall writes from Cambridge:—"Dr. Hindle has never been in Africa, and he is alive and well. He is expecting to leave for the front at any moment as a divisional signal officer in the R.E. I shall be much obliged to you if you will help me to make the facts known, as the statement in *Science* has caused unnecessary pain to Dr. Hindle's friends in many parts of the world."

A CORRESPONDENT, writing from Amsterdam in the *Times* of October 22, contributes incidentally some interesting observations on the effects of distant gun-firing. "At more than one point in the southern frontier" of Holland, he says, "one hears the guns from the French front," the distance being about a hundred miles. "It is difficult to say whether one really hears them with one's ears or whether one feels them. It is not, at this distance, a definite sound so much as a jarring and throbbing of the air. But it is audible, or sensible, enough that one can pick out the detonations of pieces of different calibre, the almost continuous low muttering (for heavy work was going on) of the smaller guns being punctuated at intervals with the double shock of something much bigger."

AT the annual statutory meeting of the Royal Society of Edinburgh on October 25 the following were elected as council:—*President*: Dr. J. Horne; *Vice-Presidents*: Prof. F. O. Bower, Sir T. R. Fraser, Dr. B. N. Peach, Sir E. A. Schäfer, the Right Hon. Sir J. H. A. Macdonald, and Prof. R. A. Sampson; *General Secretary*: Dr. Cargill G. Knott; *Secretaries to Ordinary Meetings*: Dr. R. Kidston and Prof. A. Robinson; *Treasurer*: Mr. J. Currie; *Curator of Library and Museum*: Dr. J. S. Black; *Councillors*: Principal A. P. Laurie, Prof. J. Graham Kerr, Dr. L. Dobbin, Dr. E. M. Wedderburn, Dr. W. B. Blaikie, Principal O. C. Bradley, Dr. R. S. MacDougall, Dr. W. A. Tait, Dr. J. H. Ashworth, Prof. C. G. Barkla, Prof. C. R. Marshall, Principal A. Crichton Mitchell. Sir William Turner, former president, is a permanent member of council.

IN addition to the awards announced in April for papers read at the meetings, the council of the Institution of Civil Engineers has made the following awards for papers published in the Proceedings without discussion during the session 1914–15:—A Telford gold medal to Mr. James Forgie (New York); Telford premiums to Messrs. J. R. Mason (Dunedin, N.Z.), Harold Berridge (Aden), C. R. White (London), C. S. Churchill (Roanoke, Va.); and the Trevithick premium to Mr. A. Poulsen (Lemvig, Denmark). The Indian premium for 1915 has been awarded to Mr. C. W. Anderson (Midnapore, India). The ninety-seventh session of the Institution will be opened on Tuesday, November 2, at 8 p.m., when Mr. Alexander Ross, president, will deliver an address, and will present awards made by the council for papers read and discussed or otherwise dealt with during the past session.

A MEETING of the National Illumination Committee of Great Britain was held on October 20, when Mr. W. Duddell was elected chairman of the committee in succession to the late Mr. Edward Allen. Reports on observations carried out at the instance of the committee at a number of technical laboratories, on the height to which the flame of the Hefner amylacetate lamp should be raised to afford a light of one international or English standard candle, were discussed, and their further consideration was postponed until fuller details of some of the observations and other reports which had been promised had been obtained. A report prepared and sent by Dr. E. Ott, of Zürich, on researches which had been carried out in Switzerland on the effect of atmospheric pressure, humidity, and vitiation on the light afforded by the Hefner standard lamp was considered, and it was decided, subject to Dr. Ott's consent being obtained, to prepare a translation of the report for communication to the British technical Press.

THE *Mining Magazine* of October 14 contains an article on weights and measures dealing in a practical manner with the question of the necessity for some reform in our present system. The substitution of the metric system is advocated, but more from the point of view of the technical man than from that of the general trading community. It is pointed out that the modifications which the adoption of the metric system would introduce in mining and metallurgical work are not such as to cause any inconvenience, while on the other hand the confusion which at present exists owing to the various tons, gallons, etc., recognised in the mining profession would be entirely obviated. It is also suggested that if the adoption of the metric system is regarded as too revolutionary for the English-speaking nations, or if the present is not a suitable time for conducting an agitation in its favour, some steps can at least be taken by technical men towards simplifying the British system and agreeing upon a common usage. Various examples are given with the object of illustrating the need for a less complicated and more practical system. The general adoption of the short ton, which is much used in mining circles for recording ore mined or developed, is strongly advocated. Engineers are advised to use the metric

system wherever possible, and always to champion it; to use the simplest of English weights and measures and in cases of uncertainty to specify the unit; and further, to avoid, when addressing an English audience, the use of denominations of weights and measures not likely to be understood.

THE civil engineering profession, and especially that section of it connected with river training and coastal defence work, will learn with regret of the death, at the age of eighty-three, of Mr. W. H. Wheeler, formerly of Boston, Lincs, but latterly residing at Bromley, Kent. He practised for many years in the district bordering on the Wash, and became an authority on the drainage of fens and low lands, and the regulation of estuary channels, as also on coastal phenomena generally. His "History of the Fens of South Lincolnshire" is, perhaps, his best known work; it was first published in 1868, and was reissued as a second edition in 1897. Other volumes which followed were "Tidal Rivers: their Hydraulics, Improvement, and Navigation," in Longmans's Civil Engineering Series, 1893; "The Sea Coast: (1) Destruction, (2) Littoral Drift, and (3) Protection," 1902; a "Practical Manual on Tides and Waves," 1906; and "The North Sea: Physical Characteristics, Tides, Currents, and Fishery," 1908. His pen was very prolific, and he contributed a great number of papers to professional societies and articles to technical journals, as well as to our own columns, all bearing on the branch of work which he had made peculiarly his own, and on which, despite inevitable occasional divergences of opinion from professional colleagues on controversial matters, he was ever listened to with attention and respect. He was elected a member of the Institution of Civil Engineers in 1867, and was the recipient of a Telford premium from that body.

A FEW further particulars are available as to the recent long-distance tests in wireless telephony in the United States to which reference was made in NATURE of October 7 (p. 155), but no data have yet been disclosed concerning the type of apparatus employed in the tests. The transmitting apparatus was installed in the U.S. Government wireless station at Arlington, while receiving sets only were used at Mare Island and Pearl Harbour stations. The distance between Arlington and Mare Island is about 2500 miles, and between Arlington and Pearl Harbour 4900 miles. The conversation was overheard at several points, including Darien, Panama, a distance of more than 2000 miles from the transmitting station. The tests are the outcome of many years of painstaking experiments. Early in the spring of this year the system had been developed up to a point where good results were secured over a distance of 250 miles, employing for the aerial an experimental tower erected at Montauk Point, Long Island, and a small tower at Wilmington, Del. This was followed by tests between Montauk Point and St. Simons Island, Ga., a distance of 1000 miles. No novel features are claimed for the system, which is said to be simply the perfection of existing methods. Further and extended trials under varying conditions are necessary, however, before we can state with tolerable certainty whether the problem of long-distance wireless telephony has been satisfactorily solved.

THE Trustees of the National Museum, Melbourne, have issued a second and revised edition of the "Guide to the Ethnological Collections," compiled by Dr. Baldwin Spencer. The older specimens are largely due to Mr. Brough Smith, but they have been largely increased by those made by Dr. Spencer and the late Mr. Gillen in the course of their famous journeys among the Arunta and other tribes. A short introduction gives the latest views on the ethnology of the continent. Specially remarkable are the rare specimens illustrating religious usages, totemism, initiation ceremonies, and the like. The handbook, which is well illustrated, will be indispensable to all students of the Australian aborigines.

MR. MORTEN P. PORSILD, writing from Disco, Greenland, has published a valuable monograph entitled "Studies on the Material Culture of the Eskimo in West Greenland." He adopts the scientific method of discussing in the case of each implement the object aimed at in its construction; the mode of use in order to attain this object; how its form is adapted to its use; how far the nature of the material has influenced its form. He points out that the study of Eskimo culture is specially useful for comparison with that of the European Stone Age people. He concludes that this culture developed in the Arctic area without any borrowing from foreign civilisations, except in the case of the bow and arrow. He finds that the types of the kayak have a regional distribution similar to that of the Greenland dialects. Many implements are for the first time described, and these notes serve to modify certain current theories. He warns museum collectors against the purchase of so-called "models," and he remarks that though faked antiquities are very rare, yet they may be sometimes met with.

OF pelagic Annelids, the Alciopidæ and the Tomopteridæ, not a single species has hitherto been obtained from Japanese waters. Mr. Akira Izuka is therefore to be congratulated on having, in the course of his researches, brought to light no fewer than nine species belonging to these families. Three of the species thereof are new to science. He describes his captures in the Journal of the College of Science of the Imperial University of Tokio (vol. xxxvi., art. 5).

ACCORDING to Dr. J. H. Vernhout, in the July issue of *Zoologische Mededeelingen* (the organ of the Natural History Museum of Leyden), the parasitic *Petricola pholadiformis*, one of the "Venus-shells," recently introduced into British waters with American oysters, has also appeared on the Dutch coast. In addition to cases he has already recorded he now adds to this list Flushing, Isle of Walcheren, eastern Schelde, Zandvoort, and Terschelling. The introduction of American oysters into British waters has not proved an unmixed blessing. For another parasitic mollusc, *Crepidula fornicata*, the "slipper-limpet," one of the Capulidæ, introduced inadvertently into the Whitstable oyster-beds has now become a pest. Furthermore, it is slowly spreading round the coast.

AMONG the factors of elimination in the "struggle for existence," one does not usually reckon hot springs. Yet these, too, play their part. This much is apparent from the Bulletin of the University of Colorado (vol. xv., No. 6), wherein Messrs. Ellis and Henderson give an account of the Amphibia and Reptilia of Colorado. In the hot springs near Buena Vista, at an elevation of 8500 ft., they found larvæ of the Columbian toad (*Bufo boreas*) in an overflow pool at 23° C. Following the stream back, toward the spring, the temperature of the water increased rapidly, but the young toads continued abundant until the water was at 34° C. Above this point few were seen, though one small specimen was taken from water at 45° C. This toad was swimming rapidly, as if endeavouring to reach cooler water. The pools of very hot water, they remark, were death-traps for *Bufo boreas,* and numerous other animals. From one such pool, the water of which was 54° C., three large specimens of this toad and several insects were taken, the flesh of all of them being thoroughly cooked. A list of animals and plants described as new, and a key to the Entomostraca of Colorado, make up the rest of this bulletin.

IN the issue of *Knowledge* for September there is a short paper on the hairs of rock plants by K. E. Styan, with illustrations. The glandular hairs of the Saxifrages are described, and those of *S. granulata* and *S. lingulata* are figured. The three types of hairs dealt with are the silky or woolly hairs of the Edelweiss, *Sedum arachnoideum,* etc.; the stellate hairs which form a felted covering to many leaves, as in Aubretias and Alyssums, and the glandular, which may occur alone or in conjunction with one of the other types. The hairs are mainly protective against atmospheric conditions, but the glandular hairs may in some cases serve to attract insects.

A BOTANICAL survey of some fields near Leicester is a useful contribution to field botany by Miss Measham, published in the Transactions of the Leicester Literary and Philosophical Society, vol. xix. The fields are mapped, and from a study of the grasses in particular it was found possible to group certain fields together according to their types of vegetation. Fields, for instance, characterised by *Lolium perenne* form one group, while those with *Rhinanthus crista-galli* in abundance are taken as the type of another group. As a preparation for a flora of Leicestershire and Rutland, the work should prove of value.

THE Transactions of the Botanical Society of Edinburgh (vol. xxvi., part iv.) are largely occupied by an important paper on *Primula obconica,* Hance, and its microforms by Prof. Bayley Balfour. The paper is illustrated by thirty-six plates reproduced from photographs of herbarium specimens. The familiar plant *P. obconica* was collected near Ichang in 1879, and was raised from seed sent by Charles Maries to Messrs. Veitch, of Chelsea, in 1880. The type-plant grows in meadow land, but many of its forms grow on rocks in the limestone gorges. The species is widely distributed in eastern Asia, and extends into Burmah and Bhutan, *P. listeri,* King, the East Himalayan species, is mainly a sylvestral form with ivy-shaped leaves and short flower-scapes, but is linked up to the typical round-leaved *P. obconica,* with its longer flower-scapes, by a series of intermediate forms. The variants are nearer to the *obconica* type than to *listeri.* Prof. Balfour places in this Obconico-Listeri section fourteen well-marked micro-species, four of which are of his own making. *P. sino-listeri,* a glabiescent form with acute-lobed small leaves and long scapes, was collected recently by Forrest in Yunnan, and may prove to be a plant of horticultural value. It lacks the irritant property of *P. obconica,* Hance.

THE Report of the Agricultural Department of St. Lucia for the year 1914–15 is a record of steady progress, especially in connection with the lime and coconut industries. The Government lime juice factory proves to be in a flourishing condition, and products of a high quality are being prepared, of which details are given. Useful work is being done by the staff of the department in collecting the grasses of the island, both native and naturalised, with a view to their correct determination and also in order to obtain definite particulars of their economic value. The determinations of those unknown locally have been made by Mr. Hitchcock, the agrostologist to the U.S. Department of Agriculture, and useful notes are given on the more important grasses and an analysis to show their comparative feeding value.

A RELIEF model of Wales has been constructed for the National Museum, Cardiff. An account of its construction, with a geographical description of several of the blocks, has been published by the museum ("Descriptive Handbook to the Relief Model of Wales," by W. E. Whitehouse). The whole model measures 12 ft. by 10 ft. 6 in., and is on a scale of 1 in. to a mile. The vertical scale is 1 in. to 2000 ft. The museum hopes shortly to issue copies of the various blocks of the model at as low a price as possible. Despite the care that has undoubtedly been used in its construction, it is questionable whether such a model is not inferior for teaching purposes to a good contoured map on the same scale. In accuracy of detail there can be no comparison.

NEWS from Sir Aurel Stein of his explorations in Central Asia is published in the *Geographical Journal* for October (vol. xlvi., No. 4). A despatch from the Ulughart Valley dated July 10, 1915, gives an account of last winter's work in the Turfan region, which included a detailed survey of the Turfan depression and of the Kuruk-tagh mountains. The Kuruk-tagh and the Tian-shan range were linked to the trigonometrical survey of India. From Turfan Sir Aurel Stein moved to Korla in the spring, and thence to Kashgar. Large and important archæological collections were made. In a further despatch from "Camp Kara-Chem," Pamirs, August 8, 1915, Sir Aurel Stein says he is proceeding westward to the Pamir source of the Oxus. This he proposes to follow through Wakhan to Khorok, and thence to visit Roshan, Darwaz, Karategin, and so to reach the railway at Bokhara. He hopes to reach Meshed in Persia in October, and after spending the winter in Seistan, to return to India in March.

THE number and variety of the fossil reptiles and amphibians discovered in the Karoo formation of South Africa are very remarkable. Several new genera and species are described by Mr. S. H. Haughton in the Annals of the South African Museum, vol. xii., part iii., just received. Besides a well-preserved Labyrinthodont skeleton and various remains of the usual mammal-like reptiles, there is an interesting skull from the Stormberg Beds bearing much resemblance to that of Ornithosuchus from the Triassic sandstones of Elgin, Scotland.

PART of the lower jaw of a hoofed mammal with teeth like those of the peculiar extinct hoofed mammals of South America has been found in the Lower Eocene of Wyoming, U.S.A., and is described under the name of Arctostylops by Dr. W. D. Matthew in the Bulletin of the American Museum of Natural History, vol. xxxiv., art. xiv. This unexpected discovery suggests that at the beginning of the Tertiary epoch there may have been a longer and closer connection between South and North America than has hitherto been supposed. Numerous other jaws from the same formation and locality in Wyoming are referred by Dr. Matthew to primitive lemurs and insectivores. They show that at the beginning of the Eocene period the lemurs, insectivores, and carnivores cannot be clearly distinguished by the teeth alone.

A BOUND volume of "Papers from the Geological Department, Glasgow University," for 1914, has been issued by Messrs. J. Maclehose and Sons, Glasgow, with the sanction of the University Court. It is proposed to continue this publication annually. The present volume consists of reprints, of differing sizes, of papers published in various journals, some of which have been already noticed in NATURE. It remains to be seen whether a paper will be more readily traced by this mode of reproduction than in its original habitat. If the work relating to the Glasgow district were thus brought together, a new serial might be welcome; but it may be doubted if researches on South Georgia or the desiccation of the earth will be looked for under the head of the University of Glasgow. The volume is a further proof of the activity of what has become, under Prof. J. W. Gregory's influence, one of the chief schools of geology in our islands.

THE Proceedings of the American Philosophical Society for July contains an important article by Prof. A. E. Kennelley and Mr. H. O. Taylor, of Harvard University, on the extent to which the various portions of a telephone diaphragm move during vibration. The diaphragms were circular, of about 5 cm. diameter, of steel or glass, and clamped at the outer edge. The motion was observed by means of a triangular mirror of a millimetre side, one corner of which was pressed lightly against the diaphragm by the torsion of a thin phosphor-bronze strip to which the opposite side of the mirror was attached. The diaphragm was set into vibration either by the sound waves from a series of organ pipes or by alternating electric currents sent round an electromagnet behind it. In almost all cases within the telephonic range of intensity and frequency the diaphragms vibrated in their fundamental mode with the maximum displacement at or near the centre; and the law of distribution of displacement over the rest of the surface closely approximating to the theory as given by Lord Rayleigh in his "Theory of Sound."

THE *Scientific American* for October 2 contains an article on "America as her Own Chemist," giving an account of the first National Exposition of Chemical Industries, which was held in the Grand Central Palace of New York City during the week of September 20. It is stated that this exhibition illustrates in a very striking manner the remarkable advance made in the production of chemicals and dyes in the United States since Germany has been commercially isolated and prevented from exporting. The exhibition included three branches: first, chemicals, ores, metals, drugs, paints, and similar manufactured goods; secondly, apparatus and equipment for chemical laboratories; and, thirdly, machinery and equipment for manufacturing chemists, the treatment of ores, etc. Some of the most striking examples of progress were to be found in the exhibits illustrating the utilisation of waste cherry pips, raisin seeds, and apricot kernels; the application of the osage orange wood of Texas and Oklahoma in place of foreign fustic, and the production of useful products of distillation from different hardwoods. The Petrocine colours, now being manufactured from waste products of petroleum, which are being investigated by the Bureau of Foreign and Domestic Commerce, formed a striking example of new adaptations. The exhibit of the Bureau of Standards was a prominent feature of the exhibition, not only in presenting the apparatus used in the laboratories of the bureau, but also examples of chemicals, metals, ores, and materials recently tested.

AN important study of the quality of platinum ware by Messrs. G. K. Burgess and P. D. Sale is found in No. 254 of the Scientific Papers of the United States Bureau of Standards. A simple thermo-electric method has been devised to determine the degree of purity of the platinum used in platinum vessels which does not mar the article tested; it gives data for the classification of platinum in terms of its equivalent iridium (or rhodium) content. Of 164 pieces of platinum ware tested, 26 per cent. contained less than 0·5 per cent. of iridium and 67 per cent. less than 2 per cent. of this metal. A method is described of ascertaining the loss on heating of platinum crucibles by means of a suitable electric furnace containing no heated metal parts. The loss of weight due to heating per 100 sq. cm. of crucible surface at 1200° ranged from 0·71 mgrm. to 2·69 mgrm. per hour, the smaller losses being for crucibles containing rhodium and the greater losses for crucibles containing iridium. Iron appears to diminish the loss on heating, but its presence is objectionable on account of the soluble oxide formed on the crucible surface. It seems to be possible from a thermo-electric and microscopic examination of a crucible to predict its probable loss of weight on heating within fairly close limits. Suggestions are offered concerning specifications of quality for the highest grade of platinum ware, including the substitution of rhodium for iridium as a stiffening

agent, and the total elimination of iron. The nature of the disintegration of platinum and its alloys is briefly discussed.

THE announcements of Messrs. Crosby Lockwood and Son include:—A translation of Prof. Klingenberg's Large Electric Power Stations, illustrated; Oil-Field Development, by A. Beeby Thompson; Air Screws: an Analytical Study in the Application of the Analogy of an Aerofoil having a Rectilinear Motion, by M. A. S. Riach; and new editions of Naval Architect's and Shipbuilder's Pocket Book of Formulæ, Rules, and Tables (with a section on Aeronautics), by C. Mackrow and L. Woollard; Mechanical Handling of Material, by G. F. Zimmer.

MESSRS. GEORGE ALLEN AND UNWIN, LTD., will publish shortly:—Table of Compound Interest and Antilogarithms, by J. J. Stuckey, and a translation, by Dr. E. L. Schaub, of Prof. W. Wundt's Elements of Folk Psychology: Outlines of a Psychological History of the Development of Mankind.

OUR ASTRONOMICAL COLUMN.

THE GREAT METEOR OF OCTOBER 5.—A large number of descriptions of this object has reached Mr. W. F. Denning as the result of an appeal for observations published in some of the leading journals of the west of England. Mr. Denning sends us the following summary of the observations:—The meteor appears to have been widely seen over the S.W. region of England, and there were many observers in South Wales. Most of the spectators first saw a brilliant illumination of the sky and landscape, and, looking up to ascertain the cause, the end of the meteor or the luminous streak it left was at once perceived. To many of the observers in Cornwall and Devon the position of the object was in the N. by E. sky, and the streak remained visible for periods varying between two and twenty minutes.

The light evolved from the fireball at the instant of its greatest outburst is said to have exceeded that of the full moon, but there are not many really accurate accounts of its path amongst the stars. At first the streak was projected like a glowing bar among the stars between the pointers in Ursa Major and the Pole star, but it quickly became contorted and curled up, either into a ring with appendages or into an irregular ellipse, expanding as time went on, and becoming fainter.

Using many of the best observations of the meteor for comparison, the height seems to have been from 82 to 55 miles from over Lampeter to Neath, South Wales. The length of the visible course was about 42 miles, and velocity about 35 miles per second. Radiant at $248^\circ+72^\circ$; but this feature is rather doubtful, and it is hoped that further observations of the flight may yet be acquired so that the position may be tested. The eastern side of the streak expanded so quickly and with a motion decidedly eastwards that its velocity must have been equivalent to about 90 miles per hour.

PROPER MOTIONS MEASURED BY THE BLINK-MICROSCOPE.—There can be no doubt that stereoscopic or quasi-stereoscopic methods are destined to become of very great importance in astronomical work. Thus at the Lowell Observatory, Lampland has employed Pulfrich's device, the blink-microscope, for detecting variables and asteroids; at Yerkes, Slocum has shown that it is equally well adapted for finding proper motions, and the instrument has been enthusiastically adopted at the Union Observatory, Johannesburg. The director, Mr. R. T. A. Innes, can even see this instrument with standard transparent charts replacing the unwieldy durchmusterung catalogues. Already many variable stars have been discovered by its use, asteroids have been successfully picked up, and a good beginning has now been made in its application to the question of proper motions. In Circular No. 25, Union Observatory, Mr. Innes and Mr. J. Vôute, an assistant from the Leyden Observatory, who has been working at the Cape, both describe methods by which the proper motions of a number of stars in the great ω Centauri cluster have been measured. The former not only *detects*, but also *measures* the displacements with the "blink," whilst Mr. Vôute only uses it to make the selection, and then proceeds to take differential micrometric measures. The plates employed (astrographic) had been taken separated by an interval of 23·85 years. Of the 2000 stars on the plate, 30 presented measurable displacements (motions exceeding an annual value of $0{\cdot}04''$–$0{\cdot}06''$), whilst for fifty others the indications were doubtful.

THE LIGHT-CURVE OF XX CYGNI.—Several recently published papers concerning stellar variability have possessed somewhat exceptional attraction, not only in the variety of methods exemplified, but chiefly in consequence of the notable astrophysical importance of the stellar bodies investigated. Another such memoir appears in the September number of the *Astrophysical Journal*, Dr. Harlow Shapley and Martha B. Shapley presenting an account of the employment of the latest methods of photographic actinometry in the study of the light curve of XX Cygni. Previous work indicated that this star was to be regarded as an abnormal Cepheid variable, exceptional not only by reason of its short period—the most rapid known—but also because it had been shown by Kron to present a greater amplitude of light-change visually than photographically. Employing the Mount Wilson 60-in. refractor on four nights, upwards of 300 photographs of the star on ordinary plates alternately with isochromatic plates with yellow screen were secured, providing the material for a photographic and photo-visual investigation of its fluctuating light. The results obtained show that the shape of the mean light-curve, and also its range, are both variable. The visual range does not exceed the photographic but apparently is somewhat smaller. It is concluded that the maxima, although occurring at regular intervals, are disturbances varying in character, the minimum being the sensibly constant condition of the star. The value of the colour index indicates an average spectrum of the F type rather than A as classified at Harvard.

ATMOSPHERIC EFFECTS OF KATHODE RAYS.—M. J. Maurer, of the Central Meteorological Bureau, Zurich, describes (No. 4813, *Astronomische Nachrichten*) for the first time what is possibly an atmospheric effect due to solar kathode rays. Having formed the opinion that times of exceptional solar activity would be especially favourable for decisive observations of a long-suspected phenomenon, arrangements were accordingly made with Prof. Wolfer, who supplied information regarding the rapid development of solar activity about the middle of last June. The result was that between 2 and 3 p.m. on June 16, with a blue sky, in addition to the water-vapour halo of 70°, there was also observed a distinct brown aureole having a maximum breadth of about 15°. Prof. Wolfer also noted that some optical effect, comparable with the interposition of a slight veil of vapour, had interfered with his solar observations. It is further pointed out that Prof. Barnard recorded an auroral display on the night of June 16.

RECENT EXCAVATIONS ON A PALÆOLITHIC SITE IN JERSEY.

DURING the past summer excavations on the Palæolithic site known as La Cotte at St. Brelade, in Jersey, have been pushed on vigorously. When the work for the year came to an end in 1914 a trench had been driven across the cave from the western to the eastern side-wall, a distance of about 40 ft. This trench was about 8 ft. from the entrance. The excavations undertaken this year had three objects in view: first, to extend the examination of the Palæolithic floor along the western side-wall, of which 25 ft. in an inward direction had been uncovered in 1911, and if possible reach the hitherto undetermined back-wall; secondly, to clear the entrance of the cave along its whole breadth by removing the barrier of talus, about 25 ft. high, on the outer side of the trench; and lastly, on the inner side of the clearing thus made, to push along the eastern side-wall.

The work of excavation is being carried on by the Société Jersiaise, with the assistance of a committee of the British Association of which Dr. R. R. Marett is chairman. So much of the season's work as had been completed by the end of July was embodied in a report presented to the British Association at the Manchester meeting; but at that time not one-half of the season's work was over. Before describing the later results, it will be convenient to give a brief summary of what had already been done for those who may not have seen the report. The opening up of the Palæolithic floor along the western wall was carried forward a further 5 ft., worked flints being found sparsely at about 2 to 4 ft. above bench-mark. The cave was cleared across its entire front. The central part proved sterile, but a richly implementiferous bed, reaching from floor level to a height of 12 ft., was found under a ledge projecting some 12 ft. along the eastern side-wall. The finds, in addition to worked flints, included a large number of cores and hammer stones. There was also a great deal of bone in fair condition, one piece being apparently the knuckle-bone of a mammoth. A specially fine set of "hemi-Solutrian" implements occurred along the top of this bed. The working under the eastern wall was pushed forward for a distance of 27 ft., and revealed a quantity of burnt bone, indicating a former hearth. Flint was plentiful but of coarse pattern.

This was the extent of the work which had been carried out at the end of July. But by that time the roof of the cave, which consisted of masses of detached blocks, weighing anything up to ten or twelve tons, held in place by clay, had become unsafe. By dynamite and other means, however, all loose blocks, amounting to many tons, were removed, and the cave made reasonably safe after a fortnight's hard work. Excavations were then continued along the western side-wall for a further distance of 6 ft., when a projecting shelf of live rock was reached. On investigation it appeared that this was not the end of the cave. The shelf was undercut by a cavity penetrating inward at an angle of 45°. Here among other implements was found one of the most perfect of Mousterian "points" hitherto obtained on the site.

The working across the front of the cave proved rich in implements, but only up to the line corresponding to the line of the roof; beyond that it yielded nothing. The clearing of the *débris* on the inner side of the trench was begun and carried to a depth of about 30 ft. from the entrance right across the breadth of the cave. The breccia in the centre proved as rich in implements as the side-wall workings. The bone was in good condition, and included a magnificent tooth of a prehistoric elephant (? Antiquus) virtually intact. The implements for the most part were of a coarse type, but finer types occurred among them.

So much for the work of the month of August. It was proposed to carry on excavations throughout September in the hope of reaching the back wall of the cave. It was realised, however, that the work of clearing the undercutting on the western side was a danger. It had cleared away the support of a column of loose rock-rubbish, some 30 or 40 ft. thick, which had descended on the cave through a more or less vertical funnel. After two days' work, which proved remarkably rich in finds, the roof of the cave collapsed. Careful watch had been kept and no one was hurt, though warning was short—only a matter of minutes. About 1000 sq. ft. of floor had been opened up, but these workings are now completely buried under *débris*. As further falls are expected, work has been closed for the year.

Inspection of the chimney, the sides of which are now revealed, shows that another 20 ft. would have reached the cliff wall. It is probable, therefore, that the line of least resistance when work begins again will be to attack the cave from the back. In the meantime, the members of the Société Jersiaise and of the committee in charge of the exploration are busily engaged in sorting and classifying the finds. That this is a work of some magnitude will be gathered from the fact that in the past season some 3000 shaped implements, besides much workshop refuse and bone, have been taken from the site. Both in the number and the character of the finds it has proved one of the richest Palæolithic sites in Europe.

E. N. FALLAIZE.

THE LIGHTING OF FACTORIES AND WORKSHOPS.[1]

AT the present time, when so many factories are working at high pressure on Government contracts, the condition of workers well deserves scientific study. This point is emphasised by the recent appointment by the Minister of Munitions of War, with the concurrence of the Home Secretary, of a committee "to inquire and advise on questions of industrial fatigue, hours of labour, and other matters affecting the health and physical efficiency of workers in munition factories and workshops."

One matter of considerable importance in the factory—the matter of lighting—has just been dealt with in the First Report of the Departmental Committee appointed by the Home Secretary in 1913. The inquiry demanded special methods of investigation, and the committee has carried out a considerable amount of work. Evidence has been received from fifty witnesses, including inspectors of factories and representatives of various trade associations and scientific and technical societies. Eighty-five works in the chief industrial centres have been visited, and about 4000 measurements of illumination carried out. A series of experiments bearing on the standards of illumination required for various purposes was carried out at the National Physical Laboratory.

Inquiries were also made, through the Foreign Office, into the legislation relating to lighting in all the chief European countries and the United States, and the results are published in an appendix. In the United Kingdom no general provisions in regard to lighting (analogous to those regarding heating and ventilation) occur in the Factory Acts, although adequate lighting is required, in general terms, in underground bakehouses and in certain dangerous

[1] First Report of the Departmental Committee on Lighting in Factories and Workshops. Vol. i., Report and Appendices (Cd. 8000); Vol. ii., Minutes of Evidence, etc. (Cd. 8001). (London: H.M.S.O. and Wyman and Sons.) Vol. i., 11*d.*; Vol. ii., 1*s.* 7*d.*

trades. On the other hand, the codes of all the chief European countries, the United States, and India contain provisions requiring adequate lighting in factories.

The results of bad lighting have been studied in detail. A statistical inquiry into the number of accidents in various industries in each month of the year points to the conclusion that inadequate lighting is a contributory cause of accidents; it is significant that in mines the number of fatal accidents in surface work is greater in the winter when there is less daylight available, and the "accident rate" in most industries studied is considerably greater by artificial than by natural illumination. The evidence of witnesses and the statements of the Accident Offices Association, which embraces most of the insurance companies interested in the Workman's Compensation Act, supports this view. Specific instances are quoted of the effect of improved lighting in increasing the output and quality of work, and there is a general impression that unsatisfactory lighting is, in various ways, prejudicial to health.

The committee recommends that:—

(1) There should be a statutory provision:—

(*a*) Requiring adequate and suitable lighting in general terms in every part of a factory and workshop, and

(*b*) Giving power to the Secretary of State to make Orders defining adequate and suitable illumination for factories and workshops or for any parts thereof or for any processes carried on therein.

It is pointed out that "adequate lighting" should comply with the following requirements:—

(*a*) Adequacy.

(*b*) A reasonable degree of constancy and uniformity of illumination over the necessary area of work.

(*c*) The placing or shading of lamps so that the light from them does not fall directly in the eyes of an operator when engaged on his work, or when looking horizontally across the workroom.

(*d*) The placing of lights so as to avoid the casting of extraneous shadows on the work.

Certain recommendations are also made regarding the amount of illumination necessary in the working areas of factories, in foundries, dangerous parts of ways and open spaces, etc., and there is a special recommendation providing for exemption in special cases. These values, which range from 0·05–0·4 ft.-candle, are prescribed in the interests of safety and convenience, and without prejudice to the special illumination required for the carrying on of work. At present the committee is not prepared to recommend standards of illumination for various classes of work which require further investigation.

In the appendices, the measurements of illumination in various classes of factories are tabulated in such a way as to show the average values existing, and it is shown that the above values, which are suggested as a practical legal minimum, impose no hardship. Many manufacturers would prefer to provide substantially higher values, and these recommendations would be mainly instrumental in improving the illumination in out-of-date factories which have lagged behind the general advance. Besides carrying out tests of the artificial lighting in factories in terms of foot-candles, the committee has also accumulated a considerable amount of information regarding the natural illumination. This is expressed in terms of the "daylight factor" (*i.e.* the relation between the illumination inside a workroom and the total unrestricted illumination out of doors). The experiments at the National Physical Laboratory illustrate the connection existing between the amount of illumination required and the character of the material illuminated, which may be expressed thus:—

Coefficient of reflection of material × illumination necessary = constant.

Other experiments bear on the relative merits of direct and indirect lighting for certain classes of work. The visibility of detail consisting of fabrics, embossed papers, engraved metal, etc., demands unidirectional illumination, and the ability to distinguish such detail is, for the same illumination, greater by direct than by indirect light.

An enterprising step in connection with this report is the issue of a short memorandum summarising its aims and conclusions, and pointing out the special interest attaching to the report at the present time, when so many factories are working overtime and preparations are being made for the period of the year when artificial lighting is mainly required.

THE TURQUOISE.[1]

DURING several years, whilst a curator in the United States National Museum, Dr. Pogue collected all the available information respecting this familiar gem-mineral, visiting for this purpose the principal museums and libraries of America and Europe. The result is an elaborate compilation with numerous footnotes giving references to the scattered literature of the subject. Being an exhaustive treatise on turquoise, although containing practically no original matter, it would have been more accessible and convenient for reference if it had been issued as a separate octavo volume, rather than being buried in the large quarto volumes of an academy publication.

The various aspects under which the subject is treated are indicated in the title. The section on geology contains a detailed account of the occurrence of the mineral at all its known localities, particularly those in Persia, the Sinai Peninsula, and the south-western portion of the United States. The States of New Mexico, Arizona, California, Nevada, and Colorado, where many ancient workings are known, have recently become important sources of the mineral, producing stones rivalling the Persian in quality. A useful table is given stating the enclosing rocks (mainly igneous rocks, and especially trachyte), the associated minerals (usually limonite, kaolin, and sericite), etc., for the more important turquoise occurrences. The mode or modes of origin of the mineral are discussed, and the general conclusion drawn that it has been formed by the percolation of surface waters through aluminous rocks containing apatite and disseminated copper minerals. An attempt is made to disentangle the confusion associated with the name "chalchihuitl" of the American aborigines. Although the early Spaniards confused several green stones under this name, it would appear that the Indians of the south-western States referred to turquoise, whilst in Mexico the material so-called was mainly jade. A detailed bibliography and a good index complete the work. The plates are, for the most part, devoted to representations of ancient ornaments set with turquoises. L. J. S.

PURPOSEFUL FORAMINIFERS.

MR. EDWARD HERON-ALLEN is to be congratulated on the interesting results which are rewarding his assiduous study of the Foraminifera. His latest contribution (*Phil. Trans.*, June, 1915) deals with the processes of reproduction and of shell-making. In addition to the production of zoospores observed

[1] "The Turquoise. A Study of its History, Mineralogy, Geology, Ethnology, Archæology, Mythology, Folklore, and Technology." By J. E. Pogue. Memoirs of the National Academy of Sciences, Washington, D.C., 1915, vol. xii., part ii., 3rd Memoir, pp. 162, 22 plates.

by Lister and others, some species exhibit viviparous reproduction and the budding-off of young individuals. The viviparous young are formed inside the parent shell and emerge by the dissolution of the base. The process demands a sacrifice of the whole of the protoplasm and of the internal septa, whereas in zoospore-production the shells of the young are formed outside the parent, from material derived from the surrounding medium, and not from the internal septa. Another method of multiplication is to bud-off a young individual from the shell-aperture of the parent. To this process and to the occasional (possibly fortuitous) mingling of the extruded protoplasm of two or more shells, is generally attributable what has been described as "plastogamy" in the Foraminifera.

In regard to shell-making, Mr. Heron-Allen has some remarkable evidence to submit of a quality which he calls "intelligence," or "an apparent development of purpose." The Foraminifer may select out of a large supply of possibilities one particular kind of material, such as sponge-spicules, minute flakes of mica, Echinoderm plates, and it may use this material in a purposive way. Thus in *Technitella legumen* "the whole shell wall consists of two distinct layers of spicules, an outer layer in which the spicules are all laid down with their long axes parallel to the long axis of the test, and an inner layer of spicules laid with their long axes at right angles to the outer layer, giving as close an approximation to the woof and warp of a textile fabric as is possible with a rigid non-flexible material such as sponge-spicules. It is obvious that by the crossing of these two layers the strength and resistance of the test to strain is enormously increased."

Or again, while *Marsipella cylindrica* forms a long and very friable tube of broken sponge-spicules, "it was left for *M. spiralis* to make the same great discovery as did the prehistoric genius who invented string—it has clearly realised that a twisted yarn is stronger than an untwisted wisp of fibre." The author maintains that "the Foraminifera exhibit the highest functions and the most 'intelligent behaviour' of which undifferentiated protoplasm has been observed to be capable."

MATHEMATICAL AND PHYSICAL SCIENCE AT THE BRITISH ASSOCIATION.

THE Section of Mathematical and Physical Science met under the presidency of Sir F. W. Dyson, whose address on the construction of the heavens appeared in NATURE of September 9.

Radio-active Elements and the Periodic Law.

Following the address, a discussion on radio-active elements and the periodic law took place. The opener, Prof. F. Soddy, explained that the discovery of a large number of radio-active disintegration products seemed at first difficult to reconcile with the periodic table of the elements; for it was clear that the existing gaps would not provide for more than a few of them. But it had been found that among them there were only three new separable elements—radium, polonium, and actinium; the others were isotopes of known elements, *i.e.*, they had identical chemical properties, although differing somewhat in atomic weight. The fundamental discovery, which brought order amongst these diverse products, was that when an α particle was expelled a shift of two places to the left in the table took place, whilst the expulsion of a β particle caused a shift of one place to the right. Since an α particle carries two positive charges, and a β particle one negative charge, this suggests that position in the periodic table is a function of the charge. Moseley's work has extended this by showing that it is true from end to end of the periodic table. Another fundamental fact is Rutherford's discovery of the nucleus of the atom, which was detected by experiments in scattering. We arrive at the conclusion that isotopes have the same *net* nuclear charge, though the gross number of positive and negative charges differs. Isotopes cannot be separated by chemical means, and hitherto diffusion methods have been unsuccessful. In view of the numerous isotopes of lead the question of the variability of the atomic weight of lead derived from different minerals becomes important; variations from 206·05 (uranium lead) to 207·67 (thorite lead) have been found. The new view of the periodic table is that it is a relation between chemical character and nuclear charge, not between character and mass; and it is possible now to state that there are exactly 92 elements up to uranium (counting isotopes as one element), of which 86 are known. We seem to be returning to the view of the Greeks and alchemists that elements are qualities, in contrast to the later view that elements are constituents.

Dr. N. Bohr pointed out that the dimensions of the nucleus are so small compared with the outer rings of electrons, that the nuclear constitution would have negligible effect on the electric field in these outer parts, only the net charge being important. Consequently, properties depending on the outer rings of electrons would be the same for all isotopes. In the case of spectral vibrations, there occurs a small term depending on the mass of the central nucleus, and accordingly we ought to look out for a small but perceptible difference between the spectra of two isotopes. Dr. F. A. Lindemann gave a theoretical argument to show that you could not have identical chemical *and* physical properties when the atomic weight differed. If the chemical properties were the same, certain physical properties must differ, and *vice versâ*. Mr. A. Fleck compared the effects of taking away charges from uranium, (*a*) by reduction (uranous salts), and (*b*) by disintegration (UrX salts). Dr. Whytlaw Gray described experiments on minute quantities of RaD, showing that it answered the chemical tests for lead. He thought it would not be difficult to observe its melting point directly. Sir E. Rutherford said that it was surprising how simply the whole system of thirty-four new products had been absorbed in the periodic table. In one case we have seven isotopes, all radio-active except one (Pb). Those which show radio-activity are distinguishable from one another by that property. Several references were made to the loss of Mr. H. G.-J. Moseley, killed at the Dardanelles, to whose researches this subject has owed so much.

The Order of Stellar Evolution.

On Thursday morning, Prof. A. Fowler opened a discussion on spectral classification of stars and the order of stellar evolution. He described the order of the types of stellar spectrum, which, according to the Draper notation, form the sequence O, B, A, F, G, K, M, and pointed out that this sequence has come to be regarded not merely as a convenient mode of description, but as actually representing successive stages of evolution. The spectra present striking evidence of a continuity extending from one end to the other of the sequence, and there are links connecting the earliest type, O, to the gaseous nebulæ. The temperatures of the stars decrease in the order of the sequence from upwards of 10,000° C. for the B stars to 3000° C. for the M stars, and at the same time the colour changes continuously from white to red. Additional evidence in support of the sequence

is obtained from laboratory researches; from types G to M, the stars show spectral lines characteristic of the "arc"; from B2 to F the "spark" lines are shown; and in the earliest divisions O to B1 the lines are for the most part unattainable in the laboratory, except by the most powerful electric discharge. These last may be described as "super-spark" stars. The evidence fully establishes a physical continuity corresponding to the Draper sequence. Prof. Fowler concluded by referring to the theory of Sir Norman Lockyer, and to Prof. Russell's hypothesis, which is closely akin to it. According to these, the stars fall into parallel series of ascending and descending temperature respectively, so that the hottest stars (types B and O) come midway in the order of evolution.

Sir Frank Dyson set forth the evidence, based on the observed luminosities and densities of the stars, which led Russell to the view that the red stars represent both the earliest and latest stages of evolution. It seems necessary to believe that some of the M stars are extremely diffused bodies, and others very dense. The Draper sequence gives the order of temperature; but the order of evolution is that of increasing density, not necessarily that of decreasing temperature. Prof. Eddington pointed out that the actual calculations of stellar density in particular cases compel us to admit that two stars having the densities respectively of water and of air can yet show the same type of spectrum; this seems to remove one of the chief objections brought against Russell's theory. The adoption of this theory would, however, play havoc with the regularity of many statistical results which have hitherto seemed orderly and intelligible. Father Cortie referred to the changes of a spectrum in a Nova, which seem to show that in these cases the nebular and type O spectra come, not before, but after the B and A stages. Prof. Nicholson and Mr. Merton discussed the nature of the Wolf-Rayet spectrum (type O). In his reply, Prof. Fowler pointed out a serious difficulty of Russell's hypothesis, that we have no celestial spectra which can be regarded as bridging the gap between primordial nebulous matter and the intensely bright giant stars of type M.

Thermionic Emission.

On Friday Prof. O. W. Richardson opened a discussion on thermionic emission. He said that he would confine his remarks to the emission of negative ions from hot bodies, which seemed to be an intrinsic property, whereas the emission of positive ions was not permanent and could be traced to impurities. The emission of negative ions increases rapidly with temperature according to the formula $C=AT^{\frac{1}{2}}e^{-b/T}$, where T is the absolute temperature. It was found, however, by H. A. Wilson and by Langmuir that the constants depend greatly on the experimental conditions. The temperature-law would follow theoretically from purely physical considerations. On the other hand, a similar law may be deduced if the effect is due to chemical action. In the experiments of Haber and Just the emission of electrons from alkali metals was observed under the action of water vapour and other agents. This is the only known case of the kind, and the distribution of energy among the emitted electrons suggests that it is something different from thermionic emission. On the question of the distribution of energy among the electrons during chemical action, Prof. Richardson had gained the impression from his experiments that it did not conform to Maxwell's law, but was more analogous to the laws governing the photoelectric effect; the facts of thermionic emission require Maxwell's law. As the best possible test between the physical and chemical theories, he had recently conducted experiments on a tungsten wire with special precautions against impurities; the emission was found to be much too great and persistent to be accounted for by residual gaseous impurities. He concluded that the action was not chemical, nor could it be a photoelectric action of the temperature radiation; and the physical theory seemed the most satisfactory.

Dr. F. A. Lindemann discussed the bearing of the experiments on the chain theory of electric conduction. Mr. E. Newbery criticised the use of tungsten in the crucial experiment on account of its great chemical activity at high temperature. Dr. J. A. Harker discussed the bearing of experiments on the electric arc under high pressure.

Miscellaneous Papers.

There was no subdivision of the Section this year, and the papers selected for reading were taken in full Section. Technical subjects were therefore avoided, and even the mathematical papers were such as would appeal to the members generally. Mr. G. H. Hardy greatly interested his audience with a paper on prime numbers. He gave an historical survey of the investigation of the distribution of primes, with particular reference to the theorem that the number of primes less than x approaches asymptotically to $x/\log x$ for large numbers. This theorem was first conjectured by Legendre, but was not proved until 1896. An explanation of the importance of the Riemann-ζ function in this connection was given. The paper is to be printed *in extenso* in the report. Prof. A. N. Whitehead, in a paper on space, time, and relativity, gave an account of the philosophical difficulties connected with space and time so far as they concern mathematicians. His remarkably simple method of arriving at the fundamental equations of the principle of relativity was especially valuable. Mr. A. A. Robb and Mr. H. R. Hassé took part in the discussion, the former explaining his method of logical development of the subject based on the idea of points arranged in "conical order."

Prof. W. H. Bragg's account of X-rays and crystal structure showed the power of the new methods of determining the arrangement of the atoms in a crystal. Instead of attempting to summarise this remarkable paper, we may refer the reader to Prof. Bragg's Bakerian lecture in the *Phil. Trans.* (vol. ccxv., p. 253), which covers similar ground. Prof. J. C. McClennan gave an account of his production of single-line spectra of cadmium and zinc, showing that the wave-lengths of the lines are connected with the ionisation potential by a relation depending on the quantum theory. Sir J. Larmor discussed the decomposition of the irregular vibrations constituting white light into regular trains of waves, when a grating or prism is used; for the prism, he gave an explanation based on the difference between wave-velocity and group-velocity in a dispersive medium.

Meteorology was represented by a paper by Mr. F. J. W. Whipple on the mechanism of cyclones, in which an account was given of the observed distribution and pressure at different heights, and the dynamical connection between the pressure-gradient and the inflow and outflow of air was discussed. In presenting the report of the committee on seismology, Prof. H. H. Turner stated that the work of plotting on a map the earthquake epicentres observed by Milne had now been completed. The epicentres were found especially on two great circles cutting at right angles. He referred also to improvements made in

the Milne seismograph by Messrs. J. J. Shaw and J. H. Burgess.

The meeting concluded on Friday afternoon with a very interesting address by Prof. Pierre Weiss on new views of magnetism, in which he described his researches on the part played by the magneton, or definite unit of magnetism, in the phenomena of iron, nickel, cobalt, and their alloys.

THE BRITISH ASSOCIATION.

SECTION K

BOTANY.

OPENING ADDRESS[1] BY PROF. W. H. LANG, F.R.S., PRESIDENT OF THE SECTION.

Phyletic and Causal Morphology.

I PROPOSE to deal with some aspects of the study of plant-morphology. In doing so I shall not accept any definition of morphology that would separate it artificially from other departments of botany. I regard the aim of plant-morphology as the study and scientific explanation of the form, structure, and development of plants. This abandons any sharp separation of morphology and physiology, and claims for morphology a wider scope than has been customary for the past fifty years. During this period the problem of morphology has been recognised as being "a purely historical one," "perfectly distinct from any of the questions with which physiology has to do," its aim being "to reconstruct the evolutionary tree." The limitation of the purpose of morphological study, expressed in these phrases from the admirable addresses delivered to this section by Dr. Scott and Prof. Bower some twenty years ago, was due to the influence of the theory of descent. I fully recognise the interest of the phyletic ideal, but am unable to regard it as the exclusive, or perhaps as the most important, object of morphological investigation. To accept the limitation of morphology to genealogical problems is inconsistent with the progress of this branch of study before the acceptance of the theory of descent, and leaves out many of the most important problems that were raised and studied by the earlier morphologists.

In the history of morphology, after it had ceased to be the handmaid of the systematic botany of the higher plants, we may broadly distinguish an idealistic period, a developmental period, and a phyletic period. The period of developmental morphology, the most fruitful and the most purely inductive in our science, was characterised by an intimate connection between morphological and physiological work. Among its contributions were studies of development or "growth histories" of whole plants and their members. These were carried out, in part at least, in order to investigate the nature of development, and such general problems found their expression at the close of the period in the "Allgemeine Morphologie" of Hofmeister. The "Origin of Species" took some years before it affected the methods and aims of botanical work. Then its effect on morphology was revolutionary, and, as in all revolutions, some of the best elements of the previous *régime* were temporarily obscured. This excessive influence of the theory of descent upon morphology did not come from Darwin himself, but from his apostle Haeckel, who gave a very precise expression to the idea of a genealogical grouping of animals and plants, illustrated by elaborate hypothetical phylogenetic trees. Such ideas rapidly dominated morphological work, and we find a special "phylogenetic method" advocated by Strasburger. The persistence of the phyletic period to the present time is shown, not only in the devotion of morphology to questions of relationship, but in the attempts made to base homologies upon descent only. Lankester's idea of homogeny can be traced to the influence of Haeckel, and nothing shows the consistency of phyletic morphology to its clear but somewhat narrow ideal so plainly as the repeated attempts to introduce into practice a sharp distinction between homogeny and homoplasy.

[1] Abridged by the author.

Prof. Bower, in his address last year and in other papers, has dealt illuminatingly with the aims and methods of phyletic morphology. I need only direct attention to some aspects of the present position of this, which bear on causal morphology. The goal of phyletic morphology has throughout been to construct the genealogical tree of the vegetable kingdom. In some ways this seems farther off than ever. Phyletic work has been its own critic, and the phylogeny of the genealogical tree, since that first very complete monophyletic one by Haeckel, affords a clear example of a reduction series. The most recent and trustworthy graphic representations of the inter-relationships of plants look more like a bundle of sticks than a tree. Consider for a moment our complete ignorance of the inter-relationships of the Algæ, Bryophyta, and Pteridophyta. Regarding the Algæ we have no direct evidence, but the comparative study of existing forms has suggested parallel developments along four or more main lines from different starting-points in a very simple unicellular ancestry. We have no clue, direct or indirect, to the ancestral forms of the Bryophyta, and it is an open question whether there may not be as many parallel series in this group as in the Algæ. The Pteridophyta seem a better case, for we have direct evidence from fossil plants as well as the comparison of living forms to assist us. Though palæobotany has added the Sphenophyllales to the existing groups of vascular cryptogams and has greatly enlarged our conceptions of the others, there is no proof of how the great groups are related to one another. As in the Bryophyta, they may represent several completely independent parallel lines. There is no evidence as to what sort of plants the Pteridophyta were derived from, and in particular none that relates them to any group of Bryophyta or Algæ. I do not want to labour the argument, but much the same can be said of the seed-plants, though there is considerable evidence and fairly general agreement as to some Gymnosperms having come from ancient Filicales. The progress of phyletic work has thus brought into relief the limitations of the possible results and the inherent difficulties. As pointed out by Prof. Bower, we can hope for detailed and definite results only in particularly favourable cases, like that of the Filicales.

The change of attitude shown in recent phyletic work towards "parallel developments in phyla which are believed to have been of distinct origin" is even more significant. Prof. Bower spoke of the prevalence of this as an "obstacle to success," and so it is if our aim is purely phyletic. In another way the demonstration of parallel developments constitutes a positive result of great value. Thus Prof. Bower's own work has led to the recognition of a number of series leading from the lower to the higher Filicales. By independent but parallel evolutionary paths, from diverse starting-points in the more ancient ferns, such similarity has been reached that systematists have placed the plants of distinct origin in the same genus. In these progressions a number of characters run more or less clearly parallel, so that the final result appears to be due "to a phyletic drift that may have affected similarly a plurality of lines of descent." This conclusion, based on detailed investigation,

appears to me to be of far-reaching importance. If a "phyletic drift" in the ferns has resulted in the independent and parallel origin of such characters as dictyostely, the mixed sorus, and the very definite type of sporangium with a vertical annulus and transverse dehiscence, the case for parallel developments in other groups is greatly strengthened. The interest shifts to the causes underlying such progressive changes as appear in parallel developments, and the problem becomes one of causal morphology rather than purely historical.

The study of parallel developments would, indeed, seem likely to throw more light on the morphology of plants than the changes traced in a pure phyletic line, for it leads us to seek for common causes, whether internal or external. We cease to be limited in our comparisons by actual relationship, or forbidden to elucidate the organisation in one group by that which has arisen independently in another. Similarly the prohibition against comparing the one generation in the life-cycle with the other falls to the ground, quite apart from any question of whether the alternation is homologous or antithetic. The methods of advance and the causal factors concerned become the important things, and if, for example, light is thrown on the organisation of the fern-plant by comparison with the gametophyte of the moss, so much the better. This, however, is frankly to abandon phylogeny as "the only real basis of morphological study," and with this any attempt to base homology on homogeny. Many of the homologies that exist between series of parallel development are what have been happily termed homologies of organisation; these are sometimes so close as to result in practical identity, at other times so distinct as to be evident homoplasies. The critical study of homologies of organisation over as wide an area as possible becomes of primary interest and importance.

Since about the beginning of the present century a change of attitude towards morphological problems has become more and more evident in several ways. It seems to be a phyletic drift affecting simultaneously a plurality of lines of thought. The increasing tendency to look upon problems of development and construction from a causal point of view is seen in the prominence given to what may be termed developmental physiology, and also in what Goebel has called organography. These deal with the same problems from different sides and neither formulates them as they appear to the morphologist. Together with genetics, they indicate the need of recognising what I prefer to call general or causal morphology.

The problems of causal morphology are not new, though most of them are still unsolved and are difficult to formulate, let alone to answer. As we have seen, they were recognised in the time of developmental morphology, though they have since been almost wholly neglected by morphologists. So far as they have been studied during the phyletic period, it has been from the physiological rather than the morphological side. Still, such problems force themselves upon the ordinary morphologist, and it is from his position that I venture to approach them. I willingly recognise, however, that causal morphology may also be regarded as a department of plant-physiology. In development, which is the essential of the problem, the distinction between morphology and physiology really disappears, even if this distinction can be usefully maintained in the study of the fully developed organism. We are brought up against a fact which is readily overlooked in these days of specialisation, that botany is the scientific study of plants.

General morphology agrees with physiology in its aim, being a causal explanation of the plant and not historical. Its problems would remain if the phyletic history were before us in full. In the present state of our ignorance, however, we need not be limited to a physico-chemical explanation of the plant. Modern physiology rightly aims at this so far as possible, but, while successful in some departments, has to adopt other methods of explanation and analysis in dealing with irritability. It is even more obvious that no physico-chemical explanation extends far enough to reach the problems of development and morphological construction. The morphologist must therefore take the complicated form and its genesis in development and strive for a morphological analysis of the developing plant. This is to attack the problem from the other side, and to work back from the phenomena of organisation toward concepts of the nature of the underlying substance.

It is to these questions of general morphology with a causal aim (for causal morphology, though convenient, is really too ambitious a name for anything we yet possess) that I wish to ask your attention. All we can do at first is to take up a new attitude towards our problems, and to gather here and there hints upon which new lines of attack may be based. This new attitude is, however, as I have pointed out, a very old one, and in adopting it we re-connect with the period of developmental morphology. Since the limited time at my disposal forbids adequate reference to historical details, and to the work and thought of many botanists in this field, let me in a word disclaim any originality in trying to express in relation to some morphological problems what seems to me the significant trend, in part deliberate and in part unconscious, of morphology at present. The methods available in causal morphology are the detailed study in selected plants of the normal development and its results, comparison over as wide an area as possible, with special attention to the essential correspondences (homologies of organisation) arrived at independently, the study of variations, mutations, and abnormalities in the light of their development, and ultimately critical experimental work. This will be evident in the following attempt to look at some old questions from the causal point of view. I shall take them as suggested by the fern, without confining my remarks to this. The fern presents all the main problems in the morphology of the vegetative organs of the higher plants, and what little I have to say regarding the further step to the seed-habit will come as a natural appendix to its consideration.

Individual Development.

Twice in its normal life-history the fern exhibits a process of development starting from the single cell and resulting in the one case in the prothallus and in the other in the fern-plant. For the present we may treat these two stages in the life-history as individuals, their development presenting the same general problems as a plant of, say, Fucus or Enteromorpha, where there is no alternation of generations. How is the morphologist to regard this process of individual development?

In the first place, we seem forced to regard the specific distinctness as holding for the germ as well as the resulting mature plant, however the relation between the germ-cell and the characters of the developed organism is to be explained. We start thus with a conception of specific substance, leaving it quite an open question on what the specific nature depends. This enables us to state the problem of development freed from all considerations of the ultimate uses of the developed structure. The course of development to the adult condition can be looked upon as the manifestation of the properties of the specific substance under certain conditions. This

decides our attitude as morphologists to the functions of the plant and to teleology. Function does not concern us except in so far as it is found to enter as a causal factor into the process of development. Similarly, until purpose can be shown to be effective as a causal factor it is merely an unfortunate expression for the result attained.

Let me remind you, also, that the individual plant, whether it be unicellular, cœnocytic, or multicellular, may behave as a whole at all stages of its development. We see this, for instance, in the germination of Œdogonium, in the germination and subsequent strengthening of the basal region in Fucus or Laminaria, in the moss-plant or fern-plant, or in a dicotyledonous tree. A system of relations is evident in the plant, expressed in the polarity and the mutual influences of the main axis and lateral branches, as well as in the influences exerted on the basal region by the distant growing parts. We thus recognise, in its most general form, the correlation of parts, a concept of proved value in botany.

To some the expression of the observed facts in this way may appear perilously mystical. I do not think so myself. It is true that the nature of the specific substance and of the system of relations is unknown to us, but it is regarded as a subject for scientific inquiry and further explanation. To recognise fully the complexity of the substance of the plant is not, however, a step towards neo-vitalism, but is perhaps our best safeguard against the dangers of this.

The wholeness of the individual, together with important phenomena of regeneration, has suggested the conclusion that something other than physico-chemical or mechanical laws are concerned in the development of the organism. To this something Driesch applies the name entelechy. Without discussing the vitalistic philosophy of the organism, or other modern phases of philosophic thought that treat life as an entity, it seems worth while to point out that they are based mainly on the consideration of animal development. It would be interesting to inquire into the difficulties that are met with in applying such views to plants, where regeneration in one form or another is the rule rather than the exception, and often does not lead to restitution of the individual. Causal morphology can recognise phenomena of development and of the individual, which are at present beyond physico-chemical explanation, and try to attack them by any methods of investigation that seem practicable, without begging the main question at the outset and then proceeding deductively. To assume any special inner director of development, be it entelechy or vital force, is to cut the knot that may ultimately be untied.

The previous experience of botany in the time of nature-philosophy may well make us cautious of solving our difficulties by the help of any new biological philosophy. On the other hand, co-operation between biology and philosophic thought is highly desirable. In this connection I should like to refer to an idea contained in Prof. Alexander's paper on the basis of realism. He suggests that there is only one matrix from which all qualities arise, and that (without introducing any fresh stuff of existence) the secondary qualities, life, and at a still higher level, mind, emerge by some grouping of the elements within the matrix. The development of this idea as it applies to life would appear to offer a real point of contact between inductive biological work and philosophy.

To return to our plant, its development, with increase in size and progressive complexity of external form and internal structure, must be considered. The power of continued development possessed by most plants and wanting in most animals makes comparison between the two kingdoms difficult. That there is no fundamental difference between the continued and the definitely limited types of embryogeny is, however, shown by plants themselves. The bryophyte sporogonium is a clear example of the latter, while the fern sporophyte is one of many examples of the former. A difference less commonly emphasised is that in the sporogonium (as in the higher animals) the later stages of development proceed by transformation of the whole of the embryo into the mature or adult condition; in the fern-plant the apical development results in successive additions of regions which then attain their mature structure by transformation of the meristematic tissue.

These distinctions are of some importance in considering the generalisation originally founded on animal development and known as the biogenetic law. That "the ontogeny is a concise and compressed recapitulation of the phylogeny" is essentially a phyletic conception. It has been more or less criticised and challenged by some distinguished zoologists, and has always been difficult to apply to plants. If we avoid being prejudiced by zoological theory and results, we do not find that the characters of the embryos of plants have given the key to doubtful questions of phylogeny. What help do they give us, for instance, in the algæ or the vascular cryptogams? The extension of the idea of recapitulation to the successively formed regions of the seedling plant requires critical examination; if admitted, it is at any rate something different from what the zoologist usually means by this. The facts—as shown, for instance, in a young fern-plant—are most interesting, but can perhaps be better looked at in another way. Development is accompanied by an increase in size of the successively formed leaves and portions of stem, and the process is often cumulative, going on more and more rapidly as the means increase until the adult proportions are attained. The same specific system of relations may thus find different expression in the developing plant as constructive materials accumulate. I do not want to imply that the question is merely a quantitative one; quality of material may be involved, or the explanation may lie still deeper. The point is that the progression is not a necessary one due to some recapitulative memory.

There are some other classes of facts, clearly cognate to normal individual development, that seem to require the causal explanation. I may mention three:—(1) Vegetatively produced plants (from bulbils, gemmæ, etc.) tend in their development to pass through stages in elaboration similar to young plants developing from a spore or zygote. The similarities are more striking the smaller the portion of material from which a start is made. (2) Branches may repeat the stages in ontogeny more or less completely also in relation to differences in the nutritive conditions. (3) In the course of continued development there may be a return to the simpler form and structure passed through on the way to the more complex. These cases of parallels to, or reversals of, the normal ontogenetic sequence suggest explanation on causal lines, but are difficulties in the way of phyletic recapitulation; the first two cases can be included under this, while the third seems definitely antagonistic. On the whole, it may be said that recapitulation cannot be accepted for plants without further evidence, and that preliminary inquiry disposes us to seek a deeper and more fruitful method of explaining the facts of development.

The development of most plant-individuals starts from a single cell, and when we compare mature

forms of various grades of complexity the unicellular condition is also our usual starting-point. What is not so generally recognised or emphasised is the importance of the filament as the primitive construction-form of most plants. I do not use the word primitive in a phyletic sense, nor in the sense of an ideal form, but to indicate a real stage in independent progressions underlying many homologies of organisation. I cannot develop this fully here, but wide comparison of independent lines of advance suggests that the main types of progress in complexity of the plant-body have involved the elaboration of the single filament with apical growth and with subordinated "branches." It is generally recognised that various groups of algæ show how a solid multicellular axis may come about, not only by the further partition of the segments of the apical cell, but by the congenital cortication of a central filament or the congenital condensation of the subordinated "branches" on to the central axis. The algæ further show the change from the dome-shaped apical cell of a filament to the sunken initial cell with two, three, or four sides. The central filament then only appears, if at all, as a subsequent differentiation in the tissue, and the segments serially cut off from the apical cell may or may not bear projecting hair-shoots or "leaves." The algæ thus attain in independent lines a construction corresponding to that of the plant in liverworts and mosses. In the various parallel series of Bryophyta the filament is not only more or less evident in the ontogeny, but may be regarded as the form underlying both thallus and shoot, between which on this view there is no fundamental distinction. The sporogonium also can be readily regarded as an elaborated filament. While the same interpretation of the fern-prothallus will readily be granted, to think of the fern-plant as the equivalent of an elaborated filament may appear far-fetched. So far from this being the case, I believe that it will be found helpful in understanding the essential morphology of the shoot. In a number of vascular cryptogams and seed-plants, there is actually a filamentous juvenile stage, the suspensor, while the growth by a single apical cell is essentially the same in the fern as in the moss and some algæ.

There follows from this a natural explanation of the growth by a single initial cell so commonly found in plants. The apical cell appears to be the one part of the massive plant-body (for instance, of Laurencia, a moss, or a fern) that persists as a filament; it is a filament one cell long. It may be replaced by a group of initial cells, as we see in some algæ, liverworts, and Pteridophyta, and this leads naturally to the small-celled meristems found in most Gymnosperms and Angiosperms. The filamentous condition is then wholly lost, though the system of relations and especially the polarity is maintained throughout all the changes in the apical meristem.

I feel confirmed in regarding the construction of the sporophyte in this fashion by the fact that it fits naturally with the conclusions resulting from the masterly comparative treatment of the embryology of the vascular cryptogams by Prof. Bower. These are (1) the primary importance of the longitudinal axis of the shoot, the position of the first root and the foot being variable; (2) the constancy of the position of the stem-apex near the centre of the epibasal half of the embryo; (3) the probability that embryos without suspensors have been derived from forms with suspensors, without any example of the converse change. These and other related facts seem to find their morphological explanation in the shoot of the sporophyte being the result of the elaboration of a filament.

The Construction of the Shoot.

The view to which we are thus led is that the uniaxial shoot is a complex whole, equivalent to the axial filament together with its congenitally associated subordinated "branches." This applies to the multicellular plant-bodies found in various independent lines of algæ and Bryophyta, whether they have definite projecting appendages of the nature of leaves or not. The discarding of the distinction between thallus and shoot, which in practice has proved an unsatisfactory one, is no great loss. Even taking the word in the narrower sense of a stem with distinct leaves, the shoots in algæ, liverworts, and mosses, though admittedly independent developments, exhibit an essential correspondence amounting to a homology of organisation. The resemblances are not analogies, for it is doubtful whether the "leaves" in the different cases correspond in function. The comparison of the shoot of the sporophyte of a vascular cryptogam with, for example, the shoot of the moss seems equally justifiable. It is only forbidden by strict phyletic morphology, which for our purpose has no jurisdiction. The general agreement as regards the leaf-arrangement between the ferns and the Bryophyta suggests that similar laws will be found to hold in the shoot of both gametophyte and sporophyte. Apart from plagiotropic shoots, there is a constructionally dorsiventral type of fern-rhizome. The leaves of this alternate as in the leafy liverworts, while the radial type of fern corresponds to the moss-shoot. It is significant that the early leaves of radially constructed ferns usually exhibit a divergence of $\frac{1}{3}$ in the seedling, passing higher up the stem into more complicated arrangements, and the same is the case in mosses. I must not enter into questions of phyllotaxy, but may remark on the hopefulness of attacking it from the study of the simpler shoots of algæ and Bryophyta rather than, as has usually been done, beginning with the flowering plants.

In some ferns (the striking example being Ceratopteris) the relation between the segmentation of the apical cell and leaf-production is as definite as in the moss, each segment giving rise to a leaf. This may hold more widely for ferns than is at present demonstrated, and the question deserves thorough re-investigation to ascertain the facts independently of any theoretical views. That the coincidence of the segmentation of the shoot expressed by the leaf-arrangement and the segmentation of an apical cell is not a necessary one is, however, clearly shown in other ferns, and is obvious in the case of shoots with a small-celled meristem. The two segmentations appear to be determined by some deeper system of relations, which may also be manifested in a cœnocytic plant-body.

In the complication of the uniaxial shoot introduced by branching also there seems to be an advantage in a wide area of comparison. The question most often discussed concerns dichotomous and monopodial branching. If the details of development are to be taken into consideration, the term "dichotomy" has usually been very loosely applied. Apparent dichotomy, the continuation of one shoot by two equally strong ones, is fairly common. But in most cases investigated in detail the branching seems to be really monopodial and the forking due to the equally strong development of a lateral branch close to the main apex, not to the division of the latter. In plants growing by a single initial cell almost the only case of strict dichotomy known is the classic one of Dictyota. The branching of the ferns has been the subject of numerous investigations, but there is a great lack of developmental data. Usually the branches stand in some definite relation to the leaves

of the shoot, behind, to one side, or on the leaf-base, itself, the most interesting but least common case being when the branch is in an axillary position. When the mature shoot only is considered, it is possible to argue for the derivation of monopodial branching from dichotomy or the converse. Even the facts obtainable from the mature plant, however, point to the dichotomous branching being a modification of the monopodial, the opposite view appearing to land us in difficulties regarding the morphology of the main shoot. It is unlikely that a dichotomy involving the division of the apical cell occurs in the fern-shoot, and comparison with the Bryophyta confirms the suspicion that the cases of dichotomy are only apparent.

In considering the construction of the shoot we are at present limited to comparison of the normal structure and development. The system of relations in the shoot of the fern, affecting in the first place the distribution of the leaves and secondly that of the branches, appears, however, to be of the same nature as in the independently evolved shoots of Bryophyta and algæ. A morphological analysis based on the simpler examples may lead on to the experimental investigation of the common construction. The relation that exists between the general construction and the vascular anatomy offers a special and more immediately hopeful problem. Here also, in considering the fern, we are assisted by homologies of organisation in other vascular cryptogams and in the more complex Bryophyta, though the algæ are of little help.

In few departments of botany has our knowledge increased so greatly and become so accurate as in that of vascular anatomy. The definiteness of the structures concerned and the fact that they have been almost as readily studied in fossil as in living plants has led to this. Not less important have been the clear concepts first of the bundle system and later of the stele under which the wealth of fact has been brought. Great progress has been made under the influence of phyletic morphology, and anatomy has adopted further conventions of its own and tended to treat the vascular system as if it had an almost independent existence in the plant. The chief method employed has been the comparative study of the mature regions, of necessity in the fossils and by choice in the case of existing plants. I do not, of course, mean to say that we are ignorant of the development of the vascular system, but the variety in it has not been adequately studied in the light of apical development. A gap in our knowledge usually comes between the apical meristem itself and the region with a developed vascular system. It is in this intermediate region that the real differentiation takes place, and the arrangement of the first vascular tracts is then modified by unequal extension of the various parts. The apical differentiation requires separate study for each grade of complexity of the vascular system, even in the same plant.

If we look at the vascular system, not as if it had an independent existence or from the phyletic point of view, but as a differentiation taking place within the body of the individual plant, we can inquire as to the causal factors in the process. A deeper insight into the nature of the stele may be obtained by regarding it as the resultant of a number of factors, as part of the manifestation of the system of relations in development. The first step towards this is the critical consideration of normal developing plants, but so long as the causal influences in the developing substance of a plant remain unchanged the resulting vascular structure will remain constant. Our hope of advance lies in the study of cases where these influences are modified. Herein lies the value of abnormalities, of natural experiments, and the results of experimental interference. Possible influences that have at various times been suggested are functional stimuli, the inductive influence of the older pre-formed parts on the developing region, and formative stimuli of unknown nature proceeding from the developing region. The functional stimuli do not come into play at the time of laying down the vascular tracts, though they may have importance in their maintenance later; the inductive influence of the anatomy of older regions is excluded in the first differentiation of the vascular system in an embryo; we are thus led to attach special importance to the detection of the action of formative stimuli proceeding from the young developing primordia. We have further to take external stimuli into account, though these must act by influencing the internal system of relations.

Time will not permit of reference to the scattered literature bearing on this subject, but it may make the reality of such formative stimuli a little clearer if I refer to some examples that have turned up in the course of my morphological work. In the case of the shoot, formative influences must act in the small apical region where we have the meristematic growing point with the primordia of the leaves. There is a presumption in favour of some sort of segmental construction of the meristem in relation to the leaves, whether this coincides with the cell-segmentation or not, and such a segmental construction is reflected in the vascular system. Can we in the first place distinguish any parts played by influences from the stem-apex and the developing leaves respectively? Unfortunately we know little or nothing of the anatomical relations in the rare cases of adventitious leaf-formation. We get a little insight into the respective influences of leaf and axis, however, when we compare shoots with well-developed leaves and those without leaves or with greatly reduced leaves; this may be done between distinct plants or between different regions of the same plant. It seems to emerge from such comparisons that, as regards the xylem at least, a central strand may be independent of influences from the leaves, while the latter may not only determine the leaf-traces connecting with the central strand, but may influence the periphery of this; the result is a cylinder of outer xylem continuous with the leaf-traces. This general conception is borne out by widely different plants, the correspondences between which are homologies of organisation. I may instance the stele of the Polytrichaceæ as analysed by Mr. and Mrs. Tansley, the stele of the rhizome and aerial shoots of the Psilotaceæ, of the Lycopods with larger or smaller leaves, and the stele of the ferns at various ages of the plant. The shoot of Isoetes, which is of the Lycopod type, but has relatively large leaves, shows the composite nature of the stelar xylem particularly clearly, and also suggests how the component influences are at work in the meristematic region of the stem bringing about the resultant structure.

Owing to the small size of the shoot-apex, it is difficult to induce deviations from the normal to show the respective parts played by the central axis and by the influences from the leaf-primordia. The reality of influences proceeding backwards from developing structures is better brought out when they may be present or absent, and for this lateral buds are of special interest. As a rule, the primary development of buds has proceeded far enough to determine the connecting vascular tracts, but in the case of the dormant axillary apices of Botrychium no influence has been exercised on the vascular structure of the main shoot. When, however, such a lateral apex is called into activity, it not only forms its own vascular system as it develops, but exerts an influence backwards through permanent tissue leading to the pro-

duction of a "branch-trace" connecting with the adaxial face of the subtending leaf-trace. In Helminthostachys a similar connection is established with the stele of the main stem, and the influence may extend to the whole periphery of the main stele, inducing a continued or secondary production of xylem both behind and before the place of insertion of the branch.

These constructions were, in a sense, called forth by experimental interference, since they occurred in plants the normal apical growth of which had been arrested. Plants of Osmunda are normally unbranched, and no indication of dormant lateral apices has ever been detected. I tried on young plants of *Osmunda regalis* the experiment of injuring or destroying the apex of the shoot, with the result that in a number of them branching was induced. The vascular relations exhibited considerable variety, but in some clear cases the branch was developed in an axillary position with regard to a leaf-primordium, and its vascular connection was with the adaxial face of the subtending trace in the same fashion as in Botrychium and in some species of Zygopteris. The disturbance of the normal growth had apparently brought out (in more or less irregular form) the system of relations governing the position of development of lateral branches. The result showed the correspondence with what is the normal condition in some Zygopterideæ. It has been said from the phyletic side, and on the whole rightly, that experiment cannot reconstruct history. In the light of Dr. Kidston and Professor Gwynne-Vaughan's conclusions as to the derivation of the Osmundaceæ from a Zygopterid ancestry, this induced branching of Osmunda might almost be cited as a partial exception to the statement.

These examples will suffice to indicate the justification for a change of attitude in the study of the vascular system. Looked at in this light, the stele appears not as a characteristic thing inherited as such, but as a complex resultant. The problem gains in interest, new questions (which are different from, though not antagonistic to, phyletic problems) can be put as to stelar structure, leaf-trace structure, the venation of leaves, etc. We see this if we glance at the progression in stelar structure that accompanies the development of the young fern. The phyletic explanation has been recapitulation. We have found reason to criticise the adequacy of this as applied to external form, and the same line of criticism applies to the stelar progression. In this also the early stages may be hurried over or absent, and, still more significant, the early type of stelar structure may recur, when the shoot has fallen upon evil days and approximated in size of stem and leaf-form to the seedling condition. From such points of view the vascular system offers problems in general or causal morphology not merely of great interest, but with some possibility of solution. Thus the parallel progressions from protostely to a medullated monostele, and from protostely to solenostely and dictyostely may be treated as problems in the expansion and condensation of a stelar structure, which is itself the resultant of a system of influences. Such parallel progressions are before us within the ferns and also in other groups of vascular cryptogams.

(Alternation of generations, the morphology of the seed, and the morphology of the embryo of seed-plants were then considered from the viewpoint of causal morphology.)

Conclusion.

I have touched on a number of large questions, any one of which demanded separate treatment. My concern has not, however, been with them individually, but as cognate problems justifying the deliberate adoption of a causal explanation as the aim of morphological work. I have confined myself to problems bearing on the development and self-construction of the individual, and tried to treat them so as to illustrate the causal attitude and possible lines of attack. Preliminary speculations on the questions considered can at best contain a germ of truth, and must be subsequently adjusted in the light of further facts. I have discussed these questions rather than the smaller modifications in individual development shown in metamorphosis, partly because the latter have of late years been treated from a causal point of view, and partly because I wished to consider questions that immediately affect us as working morphologists.

Did time allow, we should naturally be led to recognise the same change of attitude in biological science toward the problems of the origin of new forms. Questions of bud-variation and mutation are clearly akin to some of those considered, and the whole subject of genetics is a special attempt at a causal explanation of form and structure and the resulting functions. Close co-operation between the morphological analysis of the plant and the genetic analysis attained by the study of hybridisation is most desirable. It is especially desirable that both should deal with structure as well as with form, and in the light of individual development.

The causal factors which have determined and guided evolution can be naturally regarded as an extension of the same line of inquiry. The Darwinian theory, and especially the exposition of the principle of natural selection, was the greatest contribution ever made to the causal explanation of the organic world. Strangely enough, it led to a period of morphological work in which the causal aim was almost lost sight of. Why evolution has taken place in certain directions and not in others is a problem to the solution of which causal morphology will contribute. The probability of orthogenesis, both in the animal and vegetable kingdoms, is again coming into prominence, however it is to be explained. When we consider the renewed activity in this field it is well to remember that, just as is the case with causal morphological work, we are picking up a broken thread in the botanical web. Lastly, as if summing up all our difficulties in one, we have the problem of adaptation. In attacking it we must realise that use and purpose have often been assumed rather than proved. We may look to scientific ecological work to help us to estimate the usefulness or the selection value of various characters of the plant. On the other hand, causal morphology may throw light on whether the "adaptation" has not, in some cases at least, arisen before there was a "use" for it. The hopeful sign in the recent study of these greater morphological problems is that the difficulties are being more intensely realised, and that rapid solutions are justly suspect. The more the causal attitude is adopted in ordinary morphological work, the more hope there is of these larger questions being inductively studied rather than argued about.

The causal aim is essentially different from the historical one, but there is no opposition between causal and phyletic morphology. They are rather mutually helpful, for there has been an evolution, not of mature plants, but of specific substances exhibiting development. A deeper insight into the nature of ontogeny is thus bound to be of assistance to phyletic morphology, while the tested results of phyletic work afford most valuable guidance in general causal morphology, though this cannot accept any limitation to single lines of descent in its comparisons.

I have tried to bring before you the possibilities of causal morphology partly because the same attention

has never been given to it in this country as to other branches of botany, and partly because if morphology be conceived in this broader spirit it need not be said that it has no practical bearing. I should not regard it as a serious disability were the study of purely scientific interest only, but this is not the case. When, if ever, we penetrate into the secrets of organisation so far as to be able to modify the organism at will (and genetics has advanced in this direction), the practical possibilities become incalculable.

Probably all of us have reflected on what changes the war may bring to botanical work. It is impossible to forecast this, but I should like to emphasise what my predecessor said in his address last year as to pure science being the root from which applied science must spring. Though results may seem far off, we must not slacken, but redouble our efforts towards the soluti)n of the fundamental problems of the organism. This can be done without any antagonism between pure and applied botany; indeed, there is every advantage in conducting investigations on plants of economic importance. It would be well if every botanist made himself really familiar with some limited portion of applied botany, so as to be able to give useful assistance and advice at need. The stimulus to investigation would amply repay the time required. Even in continuing to devote ourselves to pure botany we cannot afford to waste time and energy in purposeless work. It is written in "Alice in Wonderland" that "no wise fish goes anywhere without a porpoise," and this might hang as a text in every research laboratory.

A plant is a very mysterious and wonderful thing, and our business as botanists is to try to understand and explain it as a whole and to avoid being bound by any conventional views of the moment. We have to think of the plant as at once a physico-chemical mechanism and as a living being; to avoid either treating it as something essentially different from non-living matter or forcibly explaining it by the physics and chemistry of to-day. It is an advantage of the study of causal morphology that it requires us to keep the line between these two crudities, a line that may some day lead us to a causal explanation of the developing plant and the beginnings of a single science of botany.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

LONDON.—The course of six advanced lectures on "Stelar Anatomy in Angiosperms," by Miss E. N. Thomas, University reader in botany, announced to begin at Bedford College on November 1, has been postponed until January next.

OXFORD.—On October 26 the honorary degree of D.Sc. was conferred on Mr. Guy A. K. Marshall, director of the Imperial Bureau of Entomology. The Public Orator, in presenting Mr. Marshall, spoke of the great services rendered by him to scientific entomology during his residence in South Africa, mentioning in especial his work on Coleoptera and Lepidoptera. He also referred in appreciative terms to the valuable researches being carried on under Mr. Marshall's direction in the recently established Imperial Bureau of Entomology.

In moving Congregation for the grant of a pension to Mr. Henry Walters, assistant for forty-five years in the Clarendon Laboratory, Prof. E. B. Elliott made a sympathetic reference to the retirement of Prof. R. B. Clifton, after fifty years of devoted service to the department of physics in the University.

PROF. A. H. WHITE has resigned the chair of pathology in the school of the Royal College of Surgeons in Ireland, after a tenure of seventeen years.

DR. MICHELL CLARKE will deliver the Bradshaw lecture at the Royal College of Physicians of London on November 2, taking as his subject "Nervous Affections of the Sixth and Seventh Decades of Life"; the FitzPatrick lectures will be given on November 4 and 9, by Dr. W. H. R. Rivers, on "Medicine, Magic, and Religion"; and the Goulstonian lectures by Dr. Gordon Holmes, on November 16, 18, and 23, on "Acute Spinal Lesions, with Special Reference to those of Warfare."

THE arrangements announced in the calendar of the University of Leeds for the current session follow the same general lines of previous years. They are subject to modification in the event of rearrangements being necessitated by circumstances arising in connection with the war. As has become usual in our more modern universities, great prominence is given to the work in applied science and technology. Students may graduate in science and take for their principal subject one of the following branches:—Mechanical, civil, electrical, mining, or gas engineering; fuel and metallurgy; agriculture; colour chemistry and dyeing; and the chemistry of leather manufacture. Similarly the needs of commerce have been recognised. Students in the department of economics and commerce may take a three years' course for the degree of Bachelor of Commerce, a two years' course for the diploma in commerce, or a one year's course for the diploma in social organisation and public service. Side by side with these courses, designed to meet the special needs of the area served by the University, are others covering completely the requirements of students in arts, science, law, medicine, and so on. Evening classes in many subjects have been arranged and university extension lectures are provided in a miscellany of subjects.

SOCIETIES AND ACADEMIES.

MANCHESTER.

Literary and Philosophical Society, October 5.—Prof. S. J. Hickson, president, in the chair.—W. J. **Perry**: The relationship between the geographical distributions of megalithic monuments and ancient mines. The fact that the distribution of megalithic monuments coincides with the centres of ancient mining and coast-lines adjoining pearl-shell fisheries suggests a genetic relationship between the two kinds of activities. The megalithic monuments that have been found in various places beyond the limits of the ancient East are the tombs and temples of the mining camps of the settlements engaged in exploiting gold, silver, copper, tin, and precious stones. The search for pearl-shell led the Phœnicians, and their pupils, from the Red Sea and the Persian Gulf to India and Ceylon, to Indonesia and Japan, to the islands of the Pacific, and eventually to America; and in every spot where they settled to work the mines or collect pearl-shell they planted the germs of the Old World civilisation.

PARIS.

Academy of Sciences, October 18.—M. Ed. Perrier in the chair.—The President announced the deaths of Gaston Vasseur and Henri Fabre.—Louis **Fabry** and Henri **Blondel**: The identity of the new Comas Sola planet with 193 Ambrosie. This planet proves to be identical with that discovered in 1879 by M. Coggia.—J. **Dejust**: The use of a Venturi tube for the direct

measurement of the flow in a pipe. The main pipe is by-passed at a point on the tube and at the contracted portion of the Venturi, and an ordinary small water meter is placed in the by-pass. It is shown both by calculation and experiment that the ratio of the volumes of water flowing by the two paths is constant to within 1 per cent. for varying rates of flow, and hence that the small meter can be graduated to give the total volume of water flowing through the main pipe.—Albert **Colson**: The heats of saturation of some alkaline salts.—Maurice **Drapier**: The application of cryoscopy to chemical analysis.—Em. **Bourquelot** and A. **Aubry**: The activity, in the course of the biochemical synthesis of the β-glucosides by β-glucosidase, of the other ferments which accompany it in the emulsin.

WASHINGTON, D.C.

National Academy of Sciences (Proceedings, No. 10, vol. i.).—G. G. **MacCurdy**: The octopus motive in ancient Chiriquian art. After discussing general features of animal motives in Chiriquian art, the octopus motive, which appears hitherto not to have been identified, is traced through a number of varying forms in vases, of which six are figured in cuts.—Rh. **Erdmann**: The life-cycle of *Trypanosoma brucei* in the rat and in rat plasma. The method employed affords the means of following, outside the body of the host, the sequence of changes in the life of trypanosomes, and its use has shown dimorphic forms, latent or round, and crithidia-like forms in *Trypanosoma brucei* outside of the host.—P. W. **Bridgman**: The effect of pressure on polymorphic transitions. This note presents, in a compact form by means of diagrams, many of the essential facts concerning the effect of high hydrostatic pressure on the polymorphic transitions of thirty substances.—G. M. **Green**: Isothermally conjugate nets of space curves. A necessary and sufficient condition that a conjugate net of curves on a surface be isothermally conjugate is that at each point of the surface the pair of axis tangents, the pair of associate conjugate tangents, and the pair of anti-ray tangents be pairs of the same involution.—P. D. **Lamson**: The rôle of the liver in acute polycythæmia. There is in the body a mechanism for regulating the red corpuscle content of the blood; this mechanism is under nervous control, responding to nervous, chemical, and emotional stimuli; the adrenal glands play a part in this mechanism, and the liver is the seat of the changes which increase the number of red cells, partly by a reduction in plasma volume, and partly by bringing cells into the circulation which are not normally present.—D. A. **MacInnes**: The potentials at the junctions of salt solutions. The author directs attention to the fact that the liquid junction potential E_L of a concentration-cell of the type

$$Ag + AgCl, KCl(C_1), KCl(C_2), AgCl + Ag$$

can be derived from measurements of its electromotive force, E, and of the cation-transference number, n_c, with the aid of the equation $E_L/E = (2n_c - 1)/2n_c$. This equation involves only the assumption that the work attending the transfer from one concentration to the other of one equivalent of ion is the same for the cation as for the anion. The author substantiates this assumption by showing that this equation, when applied to the electromotive force data of Jahn, leads to nearly the same values of $E - E_L$ (which should equal the difference in the two electrode-potentials) whether the electrolyte be KCl, NaCl, or HCl.—R. G. **Aitken**: A statistical study of the visual double stars in the northern sky. At least one in every eighteen, on the average, of the stars as bright as 9·0 magnitude in the northern half of the sky is a double star visible with the 36-in. telescope. Close visual double stars are relatively more numerous in the Milky Way than elsewhere in the sky, and visual double stars as a rule revolve in relatively small orbits. Close visual double stars are rare among stars of either very early or very late spectral class.—E. B. **Babcock**: Walnut mutant investigations. The mutation takes place in female flowers only, and appears in the first generation after the mutation occurs, but on crossing with the species type it is completely recessive in the F_2 generation, and the nature of the mutation is such that only certain genetic factors are affected without having the chromosome number disturbed.—C. B. **Davenport** and H. S. **Conard**: Hereditary fragility of bone. Of a parent who early in life was affected with brittle bones at least half the children will be similarly affected, but if neither parent, though of affected stock, has shown the tendency then expectation is that none of the children will have brittle bones.

CAPE TOWN.

Royal Society of South Africa, September 15.—Dr. L. Péringuey, president, in the chair.—Ethel M. **Doidge**: South African Perisporiales: (1) Perisporiaceæ. The Perisporiaceæ and allied fungi are very plentiful in South Africa, especially in forest regions and in warm districts with a fairly plentiful rainfall. The specimens in the Union Mycological Herbarium are mostly from the Woodbush forests in the Zoutpansberg, from the Knysna, and from the coast regions of Natal; there is also a fair sprinkling from other parts of the coast and from Natal as far inland as Pietermaritzburg. The Middle and High Veld of the Transvaal are only represented by a single specimen, a species of Dimeriella collected at Bandolier Kop. All that is known of the South African Perisporiales up to the present is comprised in diagnoses and descriptions of fungi collected by Prof. MacOwan and Dr. J. Medley Wood, and in a few descriptions of fungi more recently collected and published in the *Annales Mycologici* and elsewhere. All the earlier work was done in the Grahamstown district and the coast region of Natal, so that a large part of the Union was left totally unexplored so far as this group was concerned.—Alex. **Brown**: The arrangement of successive convergents in order of accuracy. One of the most important uses of simple continued fractions is for the solution of the problem to find the fraction the denominator of which does not exceed a given integer, which shall most closely approximate to a given number commensurable or incommensurable. A practically complete solution was provided by Lagrange in 1769 in his paper, "Sur la Resolution des Equations Numériques" in the *Mémoires de l'Académie royale des Sciences et Belles-Lettres de Berlin*. His results give the fraction nearest in defect and the fraction nearest in excess satisfying the conditions. He does not, however, consider the question of deciding which of these two fractions is nearest in absolute value to the given number. The author gives a proof of the rule and a method of arranging the convergents in one set so as to show the nearest in defect, the nearest in excess, and the nearest in absolute value, satisfying the stated condition.—Alex. **Brown**: The use of a standard parabola for drawing diagrams of bending moment and of shear in a beam uniformly loaded. The important stresses in a uniform continuous beam are the shear and the bending moment; they are best shown in the form of graphs where length along the beam is taken as abscissa and the required function as ordinate.

BOOKS RECEIVED.

Smithsonian Institution. U.S. National Museum. Bulletin 82: A Monograph of the Existing Crinoids. By A. H. Clark. Vol. i., The Comatulids. Part i. Pp. vi+387. (Washington: Government Printing Office.)

Smithsonian Institution. U.S. National Museum. Contributions from the U.S. National Herbarium. Vol. xix.: Flora of New Mexico. By E. O. Wooton and P. C. Standley. Pp. 794. (Washington: Government Printing Office.)

U.S. Geological Survey. The Pleistocene of Indiana and Michigan, and the History of the Great Lakes. By F. Leverett and F. B. Taylor. Pp. 529. (Washington: Government Printing Office.)

Elementary Lessons in Electricity and Magnetism. By Prof. S. P. Thompson. New edition. Pp. xvi+744. (London: Macmillan and Co., Ltd.) 4*s*. 6*d*.

The Cambridge Pocket Diary, 1915–16. Pp. xv+255. (Cambridge: At the University Press.) 1*s*. net.

My Garden in Autumn and Winter. By E. A. Bowles. Pp. viii+272. (London: T. C. and E. C. Jack.) 5*s*. net.

An Introduction to Ethics for Training Colleges. By G. A. Johnston. Pp. x+254. (London: Macmillan and Co., Ltd.) 3*s*. net.

A Treatise on Light. By Dr. R. A. Houstoun. Pp. xi+478. (London: Longmans and Co.) 7*s*. 6*d*. net.

Is Venus Inhabited? By C. E. Housden. Pp. 39. (London: Longmans and Co.) 1*s*. 6*d*. net.

First Aid in the Laboratory and Workshop. By A. A. Eldridge and H. V. A. Briscoe. Pp. 32. (London: E. Arnold.) 1*s*. net.

Stanford's Compendium of Geography and Travel (New Issue). North America. Vol. i., Canada and Newfoundland. Second edition, revised. By Dr. H. M. Ami. Pp. xxviii+1069. (London: E. Stanford, Ltd.) 15*s*. net.

Soils: Their Properties and Management. By Profs. T. L. Lyon, E. O. Fippin, and H. O. Buckman. Pp. xxi+764. (New York: The Macmillan Company; London: Macmillan and Co., Ltd.) 8*s*. net.

Canada. Department of Mines. Geological Survey Memoir 68: A Geological Reconnaissance between Golden and Kamloops, B.C., along the Canadian Pacific Railway. By R. A. Daly. Pp. viii+260. (Ottawa: Government Printing Bureau.)

Savage Man in Central Africa. By A. L. Cureau. Translated by E. Andrews. Pp. 351. (London: T. Fisher Unwin, Ltd.) 12*s*. 6*d*. net.

Survey of India. General Report, 1913–14, from 1st October 1913 to 30th September 1914. Prepared under the direction of Col Sir S. G. Burrard. (Calcutta: Survey of India.)

Maternity and Child Welfare. By E. J. Smith. Pp. 88. (London: P. S. King and Son, Ltd.) 1*s*. net.

Transactions and Proceedings of the New Zealand Institute for the Year 1914. Vol. xlvii. Pp. vii+704. (Wellington, N.Z.: J. Mackay; London: W. Wesley and Son.)

DIARY OF SOCIETIES.

FRIDAY, OCTOBER 29.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Thomas Hawksley Lecture: The World's Sources of Fuel and Motive Power: Dr. Dugald Clerk.

SATURDAY, OCTOBER 30.

ESSEX FIELD CLUB (at the Essex Museum, Stratford), at 6.—Some Remarks on the Ease with which the guns in Flanders may be heard in Essex: Miller Christy.—The Structure and Growth of Lichens: Miss A. Lorrain Smith.—Field Notes on Essex Ornithology: F. J. Stubbs.

TUESDAY, NOVEMBER 2.

RÖNTGEN SOCIETY, at 8.15.—Presidential Address: J. H. Gardiner.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 5.—The First Siege of Troy: H. J. E. Peake.

WEDNESDAY, NOVEMBER 3.

GEOLOGICAL SOCIETY, at 5.30.—Discovery of a Fossil Elephant at Chatham: Dr. C. W. Andrews.

SOCIETY OF PUBLIC ANALYSTS, at 8.—Formic Acid as a Reagent in Essential Oil Analysis: W. H. Simmons.—Note on the Melting-point of Salicylic Acid, and a Test for the Presence of Para-hydroxybenzoic Acid: H. L. Smith.—The Persistence of Hydrogen Peroxide in Milk: F. Hinks.

ENTOMOLOGICAL SOCIETY, at 8.

THURSDAY, NOVEMBER 4.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: A Diagram to Facilitate the Study of External Ballistics: Prof. W. E. Dalby.—An Application of the Principle of Dynamical Similitude to Molecular Physics: W. B. Hardy.—The Motion of a Stream of Finite Depth past a Body: R. Jones.—Deep-sea Water Waves caused by a Local Disturbance on or beneath the Surface: K. Terazawa.—The Consumption of Carbon in the Electric Arc: W. G. Duffield.

SOCIETY OF ENGINEERS, at 7.30.

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THURSDAY, NOVEMBER 4, 1915.

SCIENCE AND NESCIENCE.

MUCH attention has been given recently in Parliament and the public Press to the subject of protective measures against Zeppelins and other hostile aircraft. The position of the matter suggests that we have here another instance of the result of neglect of scientific knowledge, and of the prevision which comes with it, in our national executive. For many years Germany has been perfecting the Zeppelin airship with the view of making it an effective weapon of war. Every failure of an airship during this period has been gleefully chronicled in our daily papers, but until Zeppelins appeared over Antwerp and rained down bombs upon the city, little serious attention was given to them by the lay Press. We should have supposed, however, that the executive officers of departments entrusted with the country's defence would be fully informed of the progress that was being made, and that practical provision would be made to meet the danger likely to arise.

It appears now that our confidence has been misplaced, and that only in recent months have scientific measures been instituted to protect the country from airship attack. It is not for us to suggest how such attacks may best be met, but we do think there might have been a more capable anticipation of them and adequate means devised to meet them. It is easy to conceive airships in the future having sufficient strength to withstand all ordinary weather, but for offensive operations of value they cannot avoid being in sight of the ground, and thus laying themselves open to attack. We trust, therefore, that the possibility of airships being able to survive the anti-aircraft gunnery of the immediate future is remote, provided that their range can be found.

We are not, however, concerned here with these technical matters so much as with the national characteristic of indifference to scientific plans of action, whether pertaining to operations during war or of industry in times of peace. So little attention is given to science in most schools and colleges that it is rare to find an administrative officer or leading writer or speaker able to make a clear distinction between it and magic. With a few exceptions, the men who control or influence the welfare of the nation have been trained in schools in which science and humanity are regarded as antithetic. We were reminded very definitely of this in the early days of the war, when German barbarisms were placed at the door of scientific education by many writers in the daily Press; and we were warned not to depart from the road of literary culture if we wished to maintain our national characteristics. Since then the need for science in connection with inventions and munitions of war has been seen, and scientific committees have been appointed for various national purposes; but their work cannot be used to the utmost until our executive officials also possess a knowledge of science.

The whole system by which men are selected for administrative posts, or other positions of influence, is archaic, and neglects the knowledge of scientific methods demanded by a modern State. It is time to understand that no man can now be considered to have received a liberal education unless he has some acquaintance with the principles and methods of science; and that works of Pasteur and Faraday should be as familiar to all as those of Victor Hugo and Tennyson. The training which ends in literary culture without science is just as incomplete as that which promotes scientific knowledge without the power of clear expression.

Judging from statements commonly made in newspapers—not only in daily papers, but also in weekly periodicals in which greater accuracy might reasonably be expected—few writers have any knowledge of natural objects and phenomena. It is scarcely too much to say that, omitting signed articles written by experts, few newspapers make any announcement relating to a scientific subject without committing a mistake. Either terms are wrongly used, or a matter of common knowledge among men of science is regarded as a remarkable discovery, or sensational claims are presented to the public as if they were established truths, though they await confirmation from the scientific world, and are mostly unworthy of serious consideration.

It may be too much to expect men of letters to possess an elementary knowledge of science, or to have any sympathy with scientific precision, but it is not unreasonable to ask for accuracy of description when they are dealing with natural facts or phenomena. They may reply that even Shakespeare was at fault in matters pertaining to natural history; but he, at any rate, reflected in his works the best knowledge of his time, which is more than can be said of most writers to-day. We are often told that men of science should cultivate the art of literary expression, but the stronger necessity for men of letters to have at least a nodding acquaintance with the out-

standing facts of natural knowledge is overlooked. A well-known writer has unkindly said, "The man of science appears to be the only man in the world who has something to say, and he is the only man who does not know how to say it." The retort invited by this remark is that the man of letters frequently has nothing to say, and he says it at great length. The first business of the man of science is to create new knowledge, and not necessarily to clothe his discoveries in a pleasing dress, though he may do so. The facts of science provide material upon which literary art may be exercised, but the two functions of exploration and fine expression are rarely found together.

The methods of accurate observation and cautious interpretation demanded of scientific investigators do not readily lend themselves to attractive description, and the results require more mental concentration to understand them than is usually demanded of a literary performance. A writer of romance can let his imagination have free play, but when natural occurrences enter into the story they should be presented accurately if the material is to be used rightly. Nothing is easier than to be deceived by appearances, or to accept an assertion without inquiring into its foundations. The scientific plan of asking for evidence, and of limiting statements to those for which good justification can be produced, is much more tiresome, yet it is the only way by which truth can be attained; and that, after all, is the highest aim.

Writers in the popular Press, and in technical papers also, frequently indulge in cheap sneers at what they call "scientific theory." In their minds the man of science lives in a world far removed from the realities of life, and knows little of material things or practical possibilities. Nothing could be more incorrect than this view. With the exception of pure mathematics and metaphysics, every branch of physical and natural science depends for its progress upon practical work in the laboratory or the field. No one appreciates the value of experimental work more than the man of science, and no one is more critical of scientific theory. Whenever a theory is put forward in scientific circles, it is always subjected to severe attack from people most competent to point out its weaknesses; and, in any case, it only survives until someone brings forward evidence which disproves it.

Whether the world recognises it or no, all its material advance has been achieved by men of science. In the arts of sculpture and architecture, in literature, in philosophy, the position gained by Greece two thousand years ago remains the standard of excellence for the moderns, whereas the last fifty years or so have seen more additions to natural knowledge than all the ages before them; and the result has been not only advance in material welfare and comfort, but also in intellectual outlook. The present era will not be remembered in future history for its art, its literature, or its drama, but for its science, by which it is placed pre-eminent above all others. Though this is undoubtedly the case, the public is still guided and taught chiefly by men who know little or nothing of scientific methods or modern learning. It is not surprising that under these conditions the nation has yet to learn how to derive the highest advantage from the great scientific forces at its disposal.

THE COMPLETE WORKS OF TYCHO BRAHE.

Tychonis Brahe Opera Omnia. Tomus II. Edidit I. L. E. Dreyer. Pp. 461. (Copenhagen: Nielsen and Lydiche, 1915.)

THE first volume of this sumptuous reprint of the complete works of Tycho Brahe was noticed in NATURE last April. There will be thirteen volumes in all, of which the second has now appeared, containing the first and second of the three parts of the *Progymnasmata.* This is a posthumous work, as although a large portion of it was printed at Hveen under Tycho's direction, it was not completed until 1602, the year after his death; Kepler saw it through the press, and added an appendix. It is a general treatise on astronomy, both observational and theoretical; it commences with a dedication to the Emperor Rudolph II., and the diploma that he granted to Tycho. A document follows that is of special interest to British readers; it is the "privilege" of copyright in Scotland for thirty years, granted to Tycho by James VI. on the occasion of his visit to Hveen in 1590, just after his marriage to Anne of Denmark. Two Latin epigrams that were sent to Tycho by James are also printed.

The motion of the sun is the first astronomical problem discussed. Tycho in the beginning followed his predecessors in assuming that the solar orbit round the earth is an eccentric circle, described with uniform motion. This assumption involves adopting an eccentricity of the orbit that is just twice the true value. Shortly before the close of his life, he and Kepler detected the error of this assumption; it was too late to alter the matter in the text, as the sheets had been struck off, but Kepler drew attention to this correction, and some similar ones, in the appendix which he added.

Tycho made a good determination of the length of the tropical year, his error being only 1 second. He also obtained a good value of the constant of precession, by comparison of his results with those of Hipparchus and Ptolemy; he was able to show that the large "trepidations" or fluctuations in this motion, that were previously believed to exist, were wholly illusory.

Tables of the sun are given in the volume, the data extending to the year 1800. The annual advance of the perigee is taken as 45″, the true value being 61″. A short table of astronomical refraction is given; Tycho was one of the first to investigate this correction; his value 34′ for the horizontal refraction agrees with modern authorities, but he gives 5″ instead of 57″ for the value at 45° altitude. The erroneous assumption of 3′ for the solar parallax vitiated the refractions that were based on solar observations. Tycho's instruments were capable of proving that the true value was much smaller, but it never occurred to him to suspect the accepted value.

The section on the moon is specially interesting, for Tycho added important facts to our knowledge of its motion. He was an independent discoverer of the "variation," even if we admit the doubtful claim of Abul Wefa to be the first discoverer; in any case his writings were unknown in Europe until long after Tycho's time. Tycho also discovered the important "annual equation," and drew attention to the "reduction" arising from the inclination of the moon's path to the ecliptic. The mean values for the parallax and semidiameter adopted by Tycho, 60′ 51″ and 17′ 0″ respectively, are both too great, and further from the truth than the values 58′ 25″ and 16′ 25″ previously adopted by Copernicus. The latter, however, adopted an eccentricity double the true value, and Tycho greatly improved this element. Lunar tables are given in the volume, and their use illustrated by calculations of the details of the eclipses of the sun and moon that occurred near the end of the year 1601.

The chapter on the determination of the coordinates of the fixed stars opens with an account of the methods previously employed for connecting their places with that of the sun. The moon had generally been employed as an intermediary, either when visible in daylight, or when eclipsed, it being obviously practicable to connect the longitude of the shadow on the moon with that of the sun. Tycho used Venus as an intermediary; he found it possible to observe it in daylight when at its greatest brilliancy; the fact of its parallax, semidiameter, and motion being much smaller than those of the moon were great advantages. His star observations are astonishingly good, considering that no optical aid was available in his day; for example, fifteen values of the right ascension of Alpha Arietis, made between 1582 and 1587, and reduced to the end of 1585, range from 26° 0′ 4″ to 26° 0′ 44″, the mean value being 26° 0′ 29″, only 19″ less than the value calculated from modern data. Such work compares favourably with some that was done after the invention of the telescope, and it must be remembered that Tycho was ignorant of the existence of nutation and aberration.

He selected Alpha Arietis as the "Lapis Angularis" of his celestial structure, its proximity to the vernal equinox rendering it convenient for this purpose. A short list of fundamental stars, mainly in the Zodiac, have their places determined with special care. Then is given a less accurate catalogue of the longitudes and latitudes of about 800 stars for the epoch 1600. This must have been a great boon to his contemporaries, as the existing star catalogues were very inaccurate. A hundred bright stars have their right ascension and declination given for 1600 and 1700.

The reprint follows the original closely in type and pagination, the illustrations being reproduced in facsimile. They include diagrams of the instruments, which claim the admiration of astronomers, as the source of the observations from which Kepler deduced the laws of planetary motion.

The work is enriched with some annotations by Dr. Dreyer, directing attention to slips and inaccuracies in Tycho's text, or giving further information on various matters of interest.

ANDREW C. D. CROMMELIN.

PLANT-BREEDING.

Plant-breeding. By Prof. L. H. Bailey. New edition, revised by Arthur W. Gilbert. Pp. xviii+474. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1915.) Price 8*s*. 6*d*. net.

THE new edition of Prof. Bailey's text-book of plant-breeding contains a good deal of fresh matter. The work first appeared in the time when no order had been perceived in the phenomena of variation or heredity, and chapters by Dr. Gilbert are introduced dealing with the recent discoveries. These sections of the book are well done so far as they go, but though various parts have been rewritten, signs of irregular growth remain, as is, indeed, in such cases unavoidable.

In his preface Prof. Bailey expresses with some frankness a regret that with the new knowledge the old simplicity of ignorance has been troubled,

and strict criticism would therefore be scarcely in place.

The book still serves what was doubtless its first purpose—to excite curiosity regarding the nature and origin of plant varieties and to suggest the enormous possibilities which still lie before the plant breeder. Special reference might have been made, in this connection, to tropical products. Few, for example, have yet realised what incalculable additions to the world's wealth can yet be made by simple means. Rubber trees, for instance, vary at least 200 per cent. in yield, and it is with amazement that a plant-breeder learns that the planters are content to sow, without regard to breeding or quality, trees which are to last many years. To a less degree this is true of cocoanuts and many other objects of tropical agriculture. The chapter on the vast progress made in the teaching and investigation of plant-breeding in the United States gives evidence that this neglect will not long continue. The practical hints might well be amplified. Nothing is said, for example, of the method of removing pollen by a water-jet, though this device was, by the way, an American invention. More curious is the silence on the subject of self-sterility, a phenomenon which, whether as an obstacle or a help, plays so large a part in the daily experience of every plant-breeder.

The author's theoretical views are occasionally novel. In particular, the statement is made that individuality in plants is something quite distinct from what it is in animals. This proposition might with value be developed in an essay elucidating some of the essential phenomena of variation, but it is by no means a self-evident truth, to say no more. From the long list of periodicals dealing more or less with the subject, the *Zeitschrift für Induktive Vererbungsund Abstammungslehre*, though by far the most important continental journal, has by some accident been omitted.

THE BRITISH RAINFALL ORGANISATION.

British Rainfall, 1914: on the Distribution of Rain in Space and Time over the British Isles during the year 1914. By Dr. H. R. Mill and C. Salter. 54th annual volume. Pp. 448. (London: E. Stanford, Ltd., 1915.) Price 10s.

THE volume contains the records of about 5500 observers in Great Britain and Ireland, and there are various articles associated with rainfall. A paper on isomeric rainfall maps of the British Isles was contributed by the director of the British Rainfall Organisation to the Royal Meteorological Society in November, 1914, and the present volume contains a summary of the paper with the monthly and seasonal maps. A frontispiece in colour shows the relation of the rainfall in 1914 to the average of 1875–1909. The distribution of rainfall in time is dealt with in various ways from the ordinary daily records. For the occurrence of rain days, droughts, and rain spells over the British Isles one hundred stations have been selected, distributed uniformly over the country. The number of rain days are given in a tabular form for each month, and graphically for the average 1892–1911 and for the year 1914.

The year may be regarded as one of average rainfall frequency in all parts of the country, with generally fewer rain days in the summer and more in the winter than in a normal year. Absolute and partial droughts are discussed; the former is represented by a period of more than fourteen consecutive days, no one of which is a rain day, while a partial drought is a period of more than twenty-eight consecutive days, the mean rainfall of which does not exceed 0·01 in. per day. A rain-spell is practically the antithesis of an absolute drought, and is a period of more than fourteen consecutive days, every one of which is a rain day; the number of rain-spells in 1914 compared with the average was slightly deficient. Monthly, yearly, and seasonal rainfalls are given in a tabular form and graphically; for the British Isles as a whole the rainfall in 1914 was 7 per cent. more than the average.

The Meteorological Office having introduced a new system of units for the official records of British meteorology, the British Rainfall Organisation has fallen into line, and has adopted the use of the millimetre as the unit for measuring the depth of rain. The annual total rainfall for all the stations is given both in millimetres and inches, and this addition has involved the widening of the page of publication. The difficulty as to a change in the definition of a rain day consequent on the use of the metric units has been postponed to next year, and no alteration in this respect has been introduced in the present volume.

Notwithstanding many difficulties arising directly and indirectly from the war, the rainfall work has been carried out in all its details, although the exigencies of the times have caused some reduction of staff, and naturally the income has dropped. Greater stress is expected next year, and a hope is expressed that the rainfall records, so essential to the good of the country, will not suffer. An effort is being made to augment the voluntary funds by the aid of which the work is carried on, but public funds are not at present available, and the Treasury has decided that in the circumstances no action can be taken,

so that the organisation has to continue to depend on its own limited resources.

The results secured are a great gain to numerous corporations, water boards, and others. The work was initiated by the late Mr. G. J. Symons more than fifty years ago, and year by year the labours of the British Rainfall Organisation have increased in value, whilst the results have become of the highest scientific importance to the country.

NEW BOOKS ON CHEMISTRY.

(1) *Chemistry of Familiar Things.* By S. S. Sadtler. Pp. xiii+320. (Philadelphia and London: J. B. Lippincott Co., 1915.) Price 7s. 6d. net.

(2) *First Course in Chemistry.* By Prof. W. McPherson and Prof. W. E. Henderson. Pp. x+416. (Boston and London: Ginn and Co., 1915.) Price 5s. 6d.

(3) *Laboratory Exercises arranged to accompany "First Course in Chemistry."* By Prof. W. McPherson and Prof. W. E. Henderson. Pp. ix+128. (Boston and London: Ginn and Co., 1915.) Price 2s.

(4) *Identification of Common Carbon Compounds.* By J. N. Rakshit. Pp. iii+222. (Calcutta: The Collegian Office, 1915.)

(1) THE author has attempted an important, though difficult, task, that of interesting the unscientific person in the achievements of chemical science. He has applied himself to it with evident zest. As he truly says, "chemistry can furnish interesting subject-matter for general consideration." The chapters follow one another in a rough, natural sequence and cover a wide field. So far as we have read, there seems to be no attempt to teach or explain general principles, but rather to convey information, and this is done in a didactic manner, which admits of neither hesitation nor question. Theories and facts are poured out with equal assurance, and a note of interrogation is rarely sounded. This is not the least defect. The style is poor and not always clear; the definitions are obscure and often inaccurate, and the text abounds in incorrect scientific and historical statements. We have picked out a score of examples, but they would fill half a column, and it seems scarcely worth while to reproduce them. It is a misfortune that a book so handsomely bound, so nicely got up and well illustrated, and upon which, no doubt, the author has expended much labour, should contain such poor stuff.

(2) The theoretical and the accompanying practical volume (3) on elementary chemistry are intended for the beginner who does not intend to pursue the subject very far, but desires such information as an educated person might be expected and, if we were not tied to tradition, ought to possess.

From this point of view the book appears to fulfil exactly the author's object. In fact, it might be used with advantage as a beginner's text-book, whatever later course he intended to pursue.

There is no attempt here to be popular at the expense of accuracy. The authors have set before themselves the task of giving a clear and logical account of the outstanding facts and theories of the science in a simple, attractive, and at the same time soundly conscientious manner.

Like many of the elementary chemistry books produced in the States, it is profusely illustrated with excellent photographs. There is much to be said in favour of such illustrations. They relieve the sober monotony of the letterpress and, provided the relief does not produce a mere picture-book, no harm can be done. But there is always this danger, and in the present case it has not been entirely circumvented. Is any useful purpose served by depicting three workmen spraying an orchard with a lime-sulphur spray, or the process of loading a block of sulphur on to a railway truck? Why is there no diagram or photograph of a sulphuric acid plant, which would be so much more instructive? These are minor defects and are heavily counterbalanced by the excellence of the text.

(3) The accompanying laboratory course contains a series of simple experimental exercises, carefully arranged and well chosen, to illustrate the theoretical points. The student is being constantly pulled up and a question thrust upon him. If he is a conscientious student he will try to answer it and so accustom himself gradually to the process of interrogating himself, which is the only intelligent way of studying practical chemistry.

(4) This little volume contains a carefully compiled list of common organic compounds, with an account of their properties and characteristic reactions, as well as a number of useful tables. It is intended as a laboratory guide to the identification of organic compounds, and in so far should afford considerable assistance to the student. There is no attempt at a scheme of systematic analysis of the compounds to be identified, but apparently a good deal of reliance is placed upon the melting-points, a list of substances being tabulated at the end in order of increasing melting-point. Whether this method of identification by melting-point is useful either

as a practical method of identification or as an intellectual exercise is open to question; we are inclined to think that it is neither the one nor the other, and that the table should only be consulted when the group character of the compound has been definitely ascertained.

The fact that the book is written by a native of Bengal and printed by a Calcutta firm explains the occasional lapses in English, which is by no means to the discredit of either publisher or author; but it does not excuse the far too numerous mistakes in the spelling of chemical names. It is unfortunate that the volume has not been read in proof by someone conversant with the language.

J. B. C.

OUR BOOKSHELF.

The Callendar Steam Tables. By Prof. H. L. *Callendar.* Pp. 39. (London: Edward Arnold, 1915.) Price 3*s.* net.

IN his Royal Society paper in 1900 and in his article on Vaporisation in the "Encyclopædia Britannica" of 1902, Prof. Callendar showed the use of a simple empirical formula connecting the pressure, density, and temperature of steam. If his formula is correct, it is possible to tabulate all the properties of steam required in engineering calculations in such ways that the numbers are more consistent with one another than any hitherto published. Mollier, of Dresden, published tables and corresponding curves calculated by this method, and these were republished in England by Ewing in 1910. Messrs. Smith and Warren calculated and published tables which were discussed in NATURE of April 3, 1913. We then gave reasons for the suggestion that perhaps such experimental results as were available scarcely justified the use of the Callendar method, in spite of the fact that Prof. Callendar is undoubtedly the highest authority on this subject. He now says that these tables form part of a larger work entitled "Properties of Steam," in which the theory of steam and experimental methods of investigation are more fully discussed and illustrated.

For the present we may, perhaps, assume that, for moderate pressures and temperatures, these tables are more correct than any hitherto published, and if this is so their value to the steam engineer cannot be over-praised. They give pound Centigrade and also pound Fahrenheit units, with pressures in pounds per square inch, volumes in cubic feet per pound, as well as kilogram Centigrade units, with pressures in kilos per square cm. and volumes in cubic metres per kilo. Table II. is the most important; it gives volume, entropy, temperature, and total heat in terms of pressure. Tables IV., V., VI., and VII. give the total heat, volume, entropy, and Gibbs's potential of super-heated and super-saturated steam. The diagram which accompanies the tables has been arranged for interesting graphical calculation. From this description steam engineers will see that, in addition to what is due for his engine experiments in Montreal, they owe the author a second deep debt of gratitude. The gas and petrol engine engineers also owe him a large debt. We do not think that there is any case of an experimental physicist since Regnault's time doing even half as much service to engineering.

J. P.

The Star Pocket-book, or How to Find your Way at Night by the Stars. By R. Weatherhead. Second impression. Pp. 92. (London: Longmans, Green and Co., 1915.) Price 1*s.* net.

THIS little manual not only provides an easy means of becoming familiar with the chief constellations and individual stars, but also shows how this knowledge may be made practically useful in the determination of position and direction during night marches. The book contains several useful tables giving among other details the time of year when certain stars transit at midnight, the highest altitudes of stars in various latitudes, and pairs of bright stars which transit at the same time. These simul-transit pairs, when vertical, mark the meridian, and also serve as pointers to a celestial pole. The new issue of the book includes some additional notes on the use of the stars as direction and time finders; and it should be found particularly helpful to soldiers and scouts at the present time.

The Cambridge Pocket Diary, 1915–1916. Pp. xv+255. (Cambridge: At the University Press, 1915.) Price 1*s.* net.

READERS whose work is connected with schools and colleges will find the arrangement of this attractively produced pocket diary very convenient. Beginning in the middle of September, it enables one to start a new diary at the commencement of the academic year. The miscellaneous information provided is intended primarily for members of the University of Cambridge.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Manganese Ore Requirements of Germany.

IN a letter, under the above title, published in NATURE of October 14, Dr. Leigh Fermor dissents from the conclusion reached in my article of July 15 on munition metals that the enemy countries can produce sufficient manganese for their steel manufacture requirements without having recourse to imports, and gives it as his opinion that they are likely to be seriously hampered by a shortage of manganese ore as soon as their accumulated stocks have been used. His conclusions are as follows:—

"(*a*) That on the outbreak of war the Teutonic Powers had no great accumulated stocks of manganese ore, perhaps a maximum of 200,000 tons; (*b*) that, assuming war conditions necessitate a maintenance of the iron and steel industries of those two countries at

a peace standard, about 600,000 tons of ore a year must be obtained from fresh sources to replace imports in time of peace; (*c*) that, allowing that the Teutonic Powers might succeed in increasing their internal production by 100,000 tons, and obtain 50,000 tons of manganese ore from Turkey, if the Allied Fleets could prevent all manganese ore from outside from reaching Germany and Austria, these countries would be faced with a shortage of 250,000 tons of manganese ore in the first year of the war, and with a shortage of 450,000 tons per year afterwards, increased to 500,000 tons per annum once the Dardanelles are forced.

"The Germans will doubtless find means of dispensing with the use of manganese ore as much as possible, and they may devise methods of utilising the manganese silicate, rhodonite, of which they appear to possess a considerable quantity; but it seems inevitable that the shortage of manganese ore, once it is felt, will hamper seriously the German iron and steel industries."

Dr. Fermor's conclusions, if correct, would mean that the German production of iron and steel must have been seriously diminished in the first year of the war, and that this diminution will be very greatly accentuated in succeeding years. Before producing evidence on this point which will, I think, be found to be decisive as to the issue between Dr. Fermor and myself, I should like to explain the reasons for the conclusion with regard to manganese at which I arrived in my article of July 15.

That article dealt with ten munition metals, and it was not possible within its limits to give more than a concise survey of the evidence bearing on each particular metal. I may say, however, that the detailed evidence which is so clearly and ably presented by Dr. Fermor with regard to manganese was available to and was considered by me, and that, excluding for the moment his brief reference to manganiferous iron ore, if this were all the evidence which had to be taken into consideration, I should have drawn the same conclusion as he has done—*i.e.*, that the enemy countries, and in particular Germany, could not supply their manganese ore requirements from internal resources.[1] There is, however, another factor which appeared to me on examination to be not only important, but vital. Dr. Fermor has also considered it, but evidently dismissed it as unimportant when he writes:—"I must note that in making the above calculations I have excluded figures for manganiferous iron ores from both the German and the world's figures as confusing the issue." It is with this factor that I must deal, for I came to the conclusion that it was decisive.

Although Germany prior to the war was a large and regular importer of manganese ores, she was by no means insensible of the technical value of her own deposits of manganiferous iron ores as a source of supply of manganese for steel production. In support of this assertion, it will be sufficient if I quote the following sentence from an article by Dr. Scheffer, of Dortmund,[2] which, it will be observed, was published shortly before the outbreak of war:—"Die Mehrzahl der Arbeiten die sich mit Manganerzen und Deutschlands Versorgung mit diesem Rohstoff befasst, beschäftigen sich nur mit der Manganversorgung Deutschlands aus dem Ausland ohne dabei zu berücksichtigen dass zur Erzeugung einer Reihe manganhaltiger Roheisensorten auch Eisenerze mit einem entsprechend niedrigeren Mangangehalt verwendet werden können und dass diese manganhaltigen Eisenerze im Inlande in grossen Mengen gefördert werden."[3]

Germany's production of manganese and manganiferous iron ores for the years 1908–1911, taken from Scheffer's paper, is appended in the following table:—

—	190 Metric	1909 Metric tons	1910 Metric tons	1911 Metric tons
(*a*) Manganese ores (above 30 per cent. Mn) ...	392	474	166	177
(*b*) Manganiferous brown iron ores (30–12 per cent. Mn)...	279,611	266,685	266,825	288,049
(*c*) Manganiferous brown iron ores (< 12–2 per cent. Mn)..	2,274,702	2,393,479	2,634,451	2,791,923

The main source of the home supply is the Siegerland.

The figures show that while the output of manganese ores is infinitesimal, there has been a large and almost steady output of the higher grade manganiferous iron ore, and a decided increase in the very large production of low-grade ore, the total output being in 1911 more than 3,000,000 tons. Calculation of the manganese tonnages of (*b*) and (*c*) gives the following figures for 1911:—

		Tons
(*b*) Mean value of 21 per cent. Mn gives	...	60,490
(*c*) Mean value of 6 per cent.[4] Mn gives	...	167,515
Total	... ...	228,005

Taking now the German steel production in 1913, the figures are as follows:—

		Tons
Total steel produced ...	...	= 18,960,000[5]
Steel exported ...	... ...	= 4,300,000
Home consumption of steel ...		= 14,660,000

Assuming an average manganese percentage of 0·75 in the finished steel, this will absorb

		Tons
		109,942
Amount available ...	... ...	= 228,005
Excess ...	...	118,063

From this it is clear that the tonnage of manganese contained in the ore as mined is ***more than double that required to be present in the finished steel.*** The excess would be available for deoxidising the fluid steel if it could be applied in a suitable form. Even here, however, it would not all be lost, for in 1911 the German blast-furnaces smelted more than 662,000 tons of manganiferous slag from open-hearth and puddling furnaces. With these facts before me, I had to consider whether the German manganiferous iron ores could be made available for steel manufacture in

[1] I am much obliged to Dr. Fermor for his explanation of the figures of American production, which is perfectly correct, for the information he gives of the mineralogical composition of the Indian ores, and for pointing out my omission of the Brazilian manganese ores.

[2] *Stahl und Eisen*, July 23, 1914, pp. 1246–1254. Other articles are published in "Glückauf," 1913.

[3] In the above article ores containing more than 30 per cent. of manganese are regarded as "manganese ores," while those containing both iron and manganese, the latter being present to the extent of anything between 2 and 30 per cent., are regarded as manganiferous iron ores. They contain technical values both in iron and manganese. The mineralogical concept of manganese and manganiferous iron ores is different; but we are only concerned with the metallurgical use of the terms.

[4] This is rather less than the mean value, but the estimate is purposely made conservative.

[5] Dr. Fermor gives this as 19·29 million tons in his first table, but this is the total *iron* production.

place of the customary ferromanganese or silico-spiegel. It has to be borne in mind that whereas in peace time in any given case that particular process holds the field which happens to be the cheapest, this is not the dominating consideration in war. If a commodity is essential for war purposes, and if the raw materials are available, it must be produced, *whatever it costs.* This being so, it appeared to me that while considerable departures would have to be made from ordinary practice, there was no insuperable difficulty in the technical problem of smelting the manganiferous iron ores in such a way as to render them available for steel production. It would not be advisable at the present time to say what my reasons were for coming to this conclusion, but I think my view would be supported by steel metallurgists generally.

Germany, however, has another source of manganese, the mineral rhodonite, which corresponds when pure to $MnSiO_3$. From this can be produced various grades of manganese silicon alloys by reduction in the electric furnace, as the following analyses show [6] :—

	No. 1. Per cent.	No. 2. Per cent.	No. 3. Per cent.
Manganese	74·2	70·3	55·0
Silicon	24·1	24·6	24·1
Iron	0·77	3·8	19·0

These products have the advantage over ferromanganese of being low in carbon, and yet possess a strong deoxidising power. Their use is specially advantageous in incorporating both manganese and silicon in steel. I was not able to obtain any figures showing the extent to which Germany was manufacturing these alloys before the war, but it appeared to me to be very probable—indeed, almost certain—that a considerable production, for which preparation would have been made, was to be expected in war time. Taking these facts into consideration, the conclusion appeared to me to be warranted that the German miners and metallurgists would, under the stimulus of necessity, be able to render their country independent of the import of manganese ores, and I therefore placed manganese in the category of metals that Germany would be able to produce from internal resources.

Dr. Fermor has come to the opposite conclusion. Much the same view was stated, though even more strongly, by a writer in the *Times* early in the spring of this year, who predicted that, owing to deficiencies in manganese supply, the German steel industry would collapse in June, 1915. Fortunately, the issue between Dr. Fermor and myself can be settled by what is, after all, the most satisfactory method, viz., the appeal to facts. I will give them briefly. The source of my information is the "Statistik des Vereins Deutscher Eisen und Stahl Industrieller," published in *Stahl und Eisen* (August 5 and September 23, 1915). There is, in my opinion, no reason for regarding the figures as incorrect. They are published in the official technical organ of the German iron and steel industry. They contain evidence of the setback caused to that industry by the outbreak of war, evidence which is supplemented in an article by Dr. Schrödter frankly admitting the difficulties with which it has had to contend,[7] and they show that those difficulties have been successfully surmounted.

Statistics of production of the various types of steel in each district are given, and may be consulted by those interested. For my purpose, however, it is sufficient to quote the monthly output of cast iron and steel from the outbreak of war for a whole year :—

Month	Cast iron Metric tons	Steel Metric tons
August, 1914	586,661	567,610
September	580,087	660,615
October	729,822	900,227
November	788,956	892,814
December	854,186	928,294
January, 1915	874,133	963,790
February	803,623	946,191
March	938,438	1,098,311
April	938,679	1,012,334
May	985,968	1,044,107
June	989,877	1,080,786
July	1,047,503	1,138,478

These figures tell their own tale, and require but little comment. Confining our attention to steel production, the output for August, 1914, the first month of the war, was only 36 per cent. of the average yield in peace time—very little more than one-third. It appears to have taken the Germans only two months to overcome their technical difficulties, as is evident from the October figures, which represent an enormous increase over those of August—rather more than 50 per cent. Apart from slight fluctuations, the figures thereafter show a steady increase, until those of the last month of the war are more than double those of the first month, and represent a rate of production rather above 72 per cent. of the peace rate. There are no signs here of an expiring industry; on the contrary, I venture to think that an unprejudiced examination of the figures shows us that it has been getting month by month into a stronger position. It may be urged that a drop of 28 per cent. represents a not unimportant shortage. But I must point out that this is calculated on the total production in peace time, when, as in 1913, 22·6 per cent. was exported. This condition no longer holds. Subtracting this amount, we obtain a difference of only 5·4 per cent. between the peace and war figures of production; in a few months this will have vanished if war requirements demand it. I estimate that before the end of this year Germany will be producing steel at the rate of between 14,000,000 and 15,000,000 tons per annum, and that that rate can be increased if necessary.

The foregoing is an achievement to which I, for one, cannot refrain from paying my tribute of admiration, even though I ventured to predict it. It is in the fullest sense of the phrase an important technical success for German metallurgists. How has it been done? Dr. Schrödter will not say. What he does say is :—"Die Erzeugung unserer jetzt auf heimische Rohstoffe angewiesenen Eisenindustrie ist so gross dass sie nicht nur alle Anforderungen von Landheer und Flotte erfüllt, sondern auch die notwendigen laufenden Mengen an Eisen für Friedenszwecke und darüber hinaus bis zu einem gewissen Grade den Bedarf für unsere benachbarten neutralen Länder zu liefern vermag. Diese erfreulicher Tatsache ist offenkundig. Wie wir uns in unseren Rohstoffen decken ist unser und unserer Metallurgen Geheimnis das wir der verbündeten Welt unserer Feinde preiszugeben natürlich keinen Anlass haben."

I think, however, there can be little doubt that the utilisation of the German manganiferous iron ores supplies the answer.

Austria has also surmounted her technical difficulties in steel production.[8] Her output is very much

[6] Bureau of Mines, U.S.A., Bulletin 77, pp. 145-46.
[7] "Die Eisen industrie im ersten Kriegs Jahr," pp. 798-800.
[8] *Stahl und Eisen*, 1914, pp. 818-19.

smaller than that of Germany, but is still by no means unimportant. The figures are as follows:—

	Tons
Production between August 1, 1913, and May 31, 1914	=819,000
Production between August 1, 1914, and May 31, 1915	=727,500
Difference	91,500

Of this drop of 91,500 tons, no fewer than 49,700 tons occurred in the first month of the war, and the following figures show that her present rate of production is greater than in the corresponding months of 1914:—

	1914 Metric tons	1915 Metric tons
January	78,300 ...	79,100
February	80,000 ...	84,500
March	107,800 ...	110,500
April	94,100 ...	99,000
May	95,500 ...	80,800

(The diminution in May, 1915, was caused by the opening of hostilities between Italy and Austria.) I have quoted the Austrian figures (which do not include Hungarian production) because in the article by Dr. Kestranek, of Vienna, from which they are taken, there is a direct reference to manganese and steel production. It is as follows:—"Die Stahlwerke Oesterreichs vermöchten die volle Höhe ihrer normalen Erzeugung zu erreichen und zu erhalten, trotz der Knappheit mancher für die Stahlerzeugung notwendige Stoffe. Man lernte rasch mit dem Verfugbaren hauszuhalten, für das Ersetzbares Ersatz zu finden, und alle im Lande vorhandenen bisher unbeachteten oder nicht voll ausgenutzten Hilfsquellen zu erschliessen. So wurde Beispielsweise die für die Stahlerzeugung heute als unentbehrlich angesehene Legierung des Ferromangans, zu deren Erzeugung man fast ausschiesslich auf die Verwendung der kaukasischen Manganerze angewiesen schien, sichergestellt durch die ökonomischen Verbrauch der noch vorhandenen grossen Vorräte an fremdländischen Manganerzen und durch Heranziehung der *im Inlande befindlichen Lägerstätten von solchen Erzen.*"

It is clear from this that the Austrians had accumulated pre-war stocks of manganese ore, and that they have succeeded in utilising their native manganiferous ores.

To sum up. Unless the evidence I have brought forward is untrustworthy—and I see no reason to doubt the figures of production, which bear ample witness to the setback both to the German and the Austrian iron and steel industries caused by the outbreak of war, which was followed by a remarkable recovery in the case of Germany (only two months later), and which has been well maintained, and indeed improved upon, during the succeeding months—then the conclusion appears to me to be fully warranted that Germany has succeeded in rendering herself independent of external supplies of manganese. According to Dr. Schrödter she is, in addition to supplying her own needs, exporting steel to her neutral neighbours.

Austria has been aided by her stocks of imported manganese ore, but has also been successful in utilising her own deposits.

So far from the figures of production showing a decline, which would certainly have set in by now if the shortage of manganiferous ore predicted by Dr. Fermor were correct, they bear witness to a remarkable degree of vitality and expansion in German steel production.

I wish to acknowledge my great indebtedness to Mr. G. C. Lloyd, the secretary of the Iron and Steel Institute, for the help he has given me in obtaining the figures of German and Austrian steel production that I have quoted.

H. C. H. CARPENTER.
Royal School of Mines, South Kensington, S.W.,
October 23.

The Government Scheme for the Organisation and Development of Scientific and Industrial Research.

THE proposal to establish a permanent State-aided organisation for the promotion of scientific research, with a view to its applications to trade and industry, is a most hopeful sign of the times, and will be welcomed in principle by scientific workers generally. But, inasmuch as any such scheme necessarily implies a certain amount of State control and direction of scientific research, and, ultimately also, of the large body of scientific workers who will be brought within its ambit, there are certain important matters to be considered and settled in principle at the outset, if the scheme is to be as fruitful and successful as it ought to be. I venture, therefore, in the spirit of a friendly critic and well-wisher to the scheme, to submit to your readers the following paragraphs embodying some of the points which seem to me to need very careful consideration, in order that the freedom and interests of individual scientific workers shall be sufficiently safeguarded and conserved.

(1) In my opinion what is most needful in this country for the development of scientific research in relation to industry is a central fund for the subsidising of a *limited* number of important lines of investigation, initiated and carried out by scientific workers and technologists of repute, who are, or have been, sufficiently in touch with practical affairs as to have acquired at first-hand a real knowledge of industrial conditions and of the economic factors which will necessarily come into play in connection with any new development. Such proposals might be initiated either by individuals so qualified, or by any group or association of such individuals, and such persons should have a strong (if not a majority) representation upon any Advisory Council or Committee appointed either to select or recommend suitable subjects for investigation, or to advise in connection with the prosecution of any investigation so selected.

(2) The selection of a particular line of research should be governed by three considerations mainly:—

(*a*) Its importance and practicability as directly bearing either upon the development or revival of national industries, and particularly of those which, although producing essential commodities (*e.g.* synthetic dyes or optical glass), have through past neglect become localised abroad, or which may conceivably be threatened in the near future, or upon questions pertaining to the future better utilisation of national resources of raw materials (*e.g.* coal and its by-products).

(*b*) The probability of there being a successful issue of the investigation within a reasonable time.

(*c*) The fact that its inauguration and continuous successful prosecution would involve expenditure beyond the financial resources either of an individual investigator (even though he may be aided by grants from the existing research funds of scientific and technical societies), or of the institution in, or in connection with, which he may be working.

(3) Broadly speaking, there are three distinct classes of investigation which would come within the above category, namely:—

(*a*) Investigations with the object of establishing new or more accurate scientific data, or methods, involved in the design of industrial appliances or plant, or in the daily scientific control and supervision of important manufacturing processes.

(*b*) Investigations with the object of effecting some modifications in the details of an existing process whereby it shall become technically and commercially more efficient.

(*c*) Investigations with the object of converting a scientific discovery (or results which may be predicated from research in pure science) into a useful scientific invention.

(4) Whilst all the above three classes of research are, or should be, essential features in any organised scheme for the benefit of trade and industry, the third class is undoubtedly, not only the most important of all, but also the one which presents the greatest executive difficulties in procedure, and unless at the outset these difficulties are both clearly recognised and equitably met, the complete success of the scheme will be seriously jeopardised.

(5) It ought to be recognised in principle that an individual scientific investigator who may seek or obtain assistance from the central national research fund should be accorded the fullest credit and protection for the ideas which he may disclose, as also direct personal access (without having to invoke the aid or interest of some intermediary person or association) to the Advisory Council or Committee (or persons representing them) administering the fund. Furthermore, if the ideas or discoveries disclosed by him are deemed important and worthy of support, as likely to result in a useful invention, not only should the further investigation of the matter be entrusted to his unhampered direction, but also, in the event of such further investigation under his direction ultimately resulting in a useful invention, his rights and interests in the commercial results of such invention should be equitably provided for and ensured.

To the objection which may be made that the acceptance by a scientific worker of assistance from a public fund for the development of his ideas or discoveries implies forfeiture on his part of any pecuniary advantage which would otherwise accrue to him, it may be replied that a scientific worker ought not to be put into a worse position in regard to the development of his discoveries, merely because he is financially assisted by the State, than he would have been had he been financed privately. It is a just and necessary principle in the development of inventions, no matter whether such development is financed by the State or by some private person or syndicate, that the inventor *qua* inventor is as much entitled in equity to a reasonable interest in the commercial results of his ideas as is the financial power that he may invoke, and unless such principle is conceded at the outset in connection with the Government scheme, it will never attract, or be invoked by, the scientific inventor for the development of his ideas. In short, invention and discovery, being essentially "individualistic" products, cannot flourish or be fully developed on a "socialistic" basis; and in every State-aided scheme there lurks the socialistic danger.

(6) If the above principle be conceded, there are doubtless formidable difficulties in carrying it out. Thus, for instance, it will be necessary to provide that the communication of an idea or discovery of an individual or group of individual scientific workers to an Advisory Board must not merely be *confidential*, but shall also confer the same sort of *provisional protection* which the lodging of a provisional specification at the Patent Office now confers. In the second place, should the further State-aided investigation of the matter result in a useful invention, not only ought the resources of the British Patent Office to be placed freely at the disposal of the inventor for the adequate protection of his invention, but also steps would have to be taken to ensure the same protection in all important foreign countries. For unless this were done, foreign manufacturers and countries would reap the reward of British scientific invention financed by the British taxpayer, without having to pay so much as a single halfpenny by way of royalties to the British people, and Great Britain would for ever sacrifice a most fruitful source of "invisible exports" in the shape of "British inventions."

Moreover, it might easily happen that an idea or invention originating in Britain, under a Government scheme without due safeguards, might be freely imported into Germany, and through German sources be patented in other countries for the benefit of Germany; such things have happened in the past under the existing patent laws, and will happen all the more in future, if the new scheme does not fully protect British scientific inventions. There thus lurks in the new scheme the serious danger of its proving an instrument and organisation whereby British brains and capital will be exploited largely for the benefit of the foreigner, and whilst such danger may perhaps be minimised by wise foresight, it is inherent in the scheme, and it is difficult to see how it can be entirely eliminated.

(7) The foregoing considerations do not, of course, apply to the first of the three classes of investigations cited in section 3 hereof, but unless they are frankly recognised and fully met at the outset, the utility of the scheme in regard to the important third class of investigation will be nullified.

The above suggestions are offered as an individual expression of opinion, which is the outcome of the writer's experience in connection with the development of his own inventions, in the hope that the final scheme will be so framed and safeguarded, in the common interests both of scientific invention and of the British public, that it may be of the utmost benefit to all concerned.

WILLIAM A. BONE.

Imperial College of Science and Technology,
London, November 2.

Science in National Affairs.

WHILE the leading article in NATURE of October 21 under the above title must meet with general approval on the part of men of science, there are one or two remarks to which I feel it my duty to direct attention in the interest of science at the present time, so far as it appears to me.

The "Scheme for the Organisation and Development of Scientific and Industrial Research," as issued in a White Paper by the Board of Education, should be carefully considered by us all. I may say that there is very good reason to believe that the gentlemen named in the article in NATURE, Mr. Arthur Henderson, Sir A. Selby-Bigge, and Dr. H. F. Heath, although their chief interests may be in "other fields than those of science," are nevertheless sincerely desirous of improvement in the position of scientific research in this country. If this is so, it is surely our duty, as well as interest, as men of science, to assist so far as we possibly can in what is undoubtedly a new opportunity. There is no doubt that the administrative chairman, Sir Wm. M'Cormick, will gladly welcome suggestions made with the intention of helping the scheme.

I would point out that the Advisory Council, which has the control of the way in which money is to be spent, consists entirely, with the exception of the chairman above named, of well-known and honoured men of science. It may probably be found necessary to place on this Council representatives of biological

science, but this is a detail, and could be done at a later date.

Whatever may be our views as to a democratic constitution, it must be remembered that it exists, and nothing but obstruction is likely to result from throwing stones at it. It is to be feared that what feeling of opposition to science is present in the democratic mind is largely due to the arrogance apt to be shown by men of science. Skill and success in a particular branch of science alone do not warrant the demand that their possessor shall be regarded as capable of expressing opinions of value on any and all questions of public importance. The same may be said, of course, of any branch of learning. But it can scarcely be held that men of science, as such, have hitherto shown an especially great capacity for business or administrative ability; perhaps it may be because opportunity has been wanting.

We must also confess that ignorance of, or want of interest in, branches of knowledge outside their own domain is not exclusively confined to men of a literary or legal training. At the same time, it may, I think, be reasonably asserted that a wide outlook is more common amongst men of science than amongst other members of the community.

May I suggest that a more conciliatory attitude than that too often assumed with respect to what seem to be well-meant efforts on the part of Government Departments would be more to our interest and for the benefit of the nation? There is, no doubt, a very great deal yet to be done in connection with the position of science in the State. But we may do much in assisting those who are inclined to look with favour on our desires and demands, although it may be that too many of the positions of authority are filled by men lacking in appreciation of the meaning and aims of science. We have an opportunity of showing our value to the nation, and, if we use it well, greater duties and responsibilities will follow.

W. M. BAYLISS.

University College, London, October 23.

[WE do not doubt for a moment that the gentlemen mentioned by Prof. Bayliss take a sympathetic interest in the promotion of scientific research, but this can scarcely be regarded as specially enabling them to administer a scheme to promote the co-ordination of science and industry. What we particularly object to is the assumption, made in all Government offices, that men without scientific knowledge are alone capable of controlling scientific departments and committees. The executive officers of the Committee and Advisory Council on Scientific and Industrial Research represent only one illustration of a principle for which there is no substantial basis. Prof. Bayliss seems disposed to concede this principle: we are not. He suggests that men of science do not possess much business or administrative capacity: we do not accept this generalisation; and we hold that they could scarcely be less effective and less enterprising than administrators trained in unscientific schools. No one supposes that skill and success in science give authority to opinions expressed on other subjects, but neither does work in literary and legal fields create ability to deal with the practical problems of science and technology. Science has too long been content to occupy a subordinate position in the national executive; and the main object of our article was to assert its claims to a higher place.—ED. NATURE.]

A New X-Ray Technique.

THE remarkable therapeutic action of radiations with a range of wave-length from $3{\cdot}8\times10^{-5}$ cm. to $0{\cdot}99\times10^{-9}$ cm. is now generally known and recognised by the medical profession. Between the limits $\lambda=1{\cdot}72\times10^{-9}$ cm., the shortest wave emitted by a Coolidge tube, and $\lambda=0{\cdot}99\times10^{-9}$ cm., the length of the waves of gamma rays from radium C, there is a gap which has so far defied all attempts at bridging.

Meanwhile, physico-physiological laboratories have their hands full with many problems concerning the action of the numerous radiations already available. Research work in this direction can only progress slowly; far more slowly, in fact, than investigations undertaken in perhaps any other branch of physics. But the prospect of final success, and in any case the task of alleviating sickness and pain, is so compelling that he who attacks this problem in the true spirit of science is unconscious of any sacrifice.

Now the various strong inducements presented to the physician by this new method of treatment have led to the hasty accumulation of a large number of facts and a mass of data which serve at the present time as the basis of modern X-ray technique. In the absence so far of any wide generalisation emanating from laboratory work, this necessary knowledge has been largely acquired by the elementary process of trial and error.

I wish, however, to refer here only to that part of the subject which relates to the treatment of deeply-seated tumours and to point out that so astonishing, both as regards action and inaction, are many of the results of treatment by this pleasant and painless means that it is very desirable to pursue the matter as systematically as possible. From the outset, the physician has met with the difficulty of administering a large dose of radiation to an internal region of the body without endangering the more superficial tissues. It has hitherto been usual, therefore, to make comparatively short exposures, taking care at the same time that the intervals between them be not too brief. In order to obviate this drawback the method of "crossfire" has been largely developed on the Continent, the patient being mapped out into several definite areas and the exposures made through several "ports of entry," with the rays always pointing towards the seat of disease.

It occurred, however, to the writer some months ago that by a suitable means of rotating a single X-ray tube and screening off with lead the rays from it, except a comparatively small pencil of them, it would be possible to bring to bear upon a deeply-seated region in the body a far greater amount of radiant energy in a given time than existed at the skin surface during treatment. Intensity of radiation is defined as the energy falling upon one square centimetre of receiving surface, and it is clear that if a conical beam of X-rays could be sent towards a diseased region so that the apex of the cone rested upon the neoplasm, the intensity of radiation there would be far greater than at the skin surface, where the area traversed by the rays is larger. But this would involve a source of rays consisting of a beam of large cross-section and the ability to concentrate it to a focus, the former condition being difficult to obtain and the latter impossible.

Nevertheless, since time enters into the question in the case of therapeutic action it is possible to approximate to the above conditions by the simple device of attaching the X-ray bulb to the circumference of a slowly revolving wheel of about 18 in. diameter, and with its axis pointing towards the diseased region. The screen is arranged to give a slanting beam that makes a convenient angle with the axis of rotation. Thus a hollow cone is swept out by the revolving pencil of rays, and it becomes possible to give a dose of radiation to a deeply-seated tumour ten or more times as great as that received by the skin. In this

way the exposure can therefore be safely made at least ten times longer than is usually possible by the ordinary method in general use and without damaging the superficial tissues.

It is to be noticed that the chief advantage of this plan lies in the fact that whereas at the apex of the cone swept out by the revolving beam the radiation is operative during the whole exposure, at the skin surface the pencil of rays only impinges upon a small area at any moment, always passing slowly on as the tube revolves so as to irradiate a large ring, section by section, of perhaps one inch in width.

Some rough experiments already made by the writer with a crude form of tube frame revolved by hand have given promising results. In spite of the fact that the source of radiation in a focus tube is practically a point, all rays being therefore divergent and their intensity falling off inversely as the square of the distance; in spite, too, of the absorption of some of the beam's energy as it traverses the tissues, it was found that the time-intensity factor could be made in this way considerably larger at the seat of the disease than at the skin surface.

The method is already being given a practical trial at the Cancer Hospital, London, and may prove later to be applicable also in treatment by radium.

C. E. S. Phillips.

Castle House, Shooters Hill, Woolwich, S.E.

Australian Photographs.

Readers of Nature, and especially members of the British Association, may be interested to know that I have received to-day (October 25), too late for incorporation in the "Overseas Camera in Australia," now being distributed to subscribers on behalf of the funds of the British Red Cross Society and Order of St. John, a remarkably fine series (300 or more) of photographs of features of general and scientific interest of New South Wales, presented by the Premier of this State through Mr. J. H. Maiden, the director of the Botanic Gardens, Sydney, and taken by the Government printer. The photographs are of interest to botanists, zoologists, foresters, agriculturists, geologists, miners, and astronomers. I shall be glad to supply lists or further particulars to anyone interested.

13 Palmerston Park, Dublin. T. Johnson.

Explosive Bombs.

I have been studying the effects of explosive bombs on windows, and should greatly appreciate any information as to the effect of the explosions on the diagrams of recording barometers: (a) in the open air, (b) in rooms.

Alfred S. E. Ackermann.

25 Victoria Street, Westminster, London, S.W., October 28.

TRENCH "FROST-BITE."

During the winter campaign of 1914–15 a number of soldiers fighting in the trenches in Flanders became disabled from the effects of cold and wet on their feet. The condition is to be distinguished from true frost-bite, in which severe cold causes necrosis or death of the tissues; but though this may occur, it is infrequent in trench frost-bite, the characteristic symptoms of which are swelling, pain, and disturbance of sensation in the part affected. For this reason Delépine[1] suggests the name "frigorism" or "frigidism" for this condition, corresponding with "froidure," used by several French writers.

Three factors seem to be concerned in the causation of trench frost-bite, viz., cold, wet, and interference with the circulation in the leg and foot by tight puttees and boots. Lorrain-Smith, Ritchie, and Dawson[2] have investigated experimentally the pathology of the condition. The microscopic examination of the tissues showed that the chief effect of the cold is exerted on the blood-vessels, which become dilated and contain a certain amount of fibrin deposit, their internal endothelial lining becomes swollen, and the muscle fibres of the middle coat are vacuolated. The axis-cylinders of the nerves of the part become swollen and œdematous, and some slight changes in the fibres of the voluntary muscles may be observed.

Delépine (*loc. cit.*) has conducted a number of experiments on the causation and prevention of trench frost-bite. He finds that exposure to cold, dry *air* caused a lowering of temperature of the part, which, however, is slight and not progressive, but immersion in a limited amount of cold *water* caused a rapid and considerable, though not permanent, lowering of temperature, and, provided the bulk of water does not exceed twice that of the part immersed, is not detrimental. When, however, the amount of water at a temperature below that of the skin is unlimited, or if the water is limited in amount but contains ice, the lowering of temperature of the part is rapid, considerable, and progressive, and invariably results in *local frigorism,* and motion of the external water accelerates loss of heat by preventing the formation of a comparatively warm surface layer. The presence of a thick woollen covering retards loss of heat, even when saturated with water, owing to the warming of the comparatively still layer of water retained within the meshes of the fabric. It was found that a very thin layer of moderately dry air between the skin and the external cold water or ice suffices to reduce the loss of heat to an extent which is compensated by the heat brought to the part by the circulating blood. Such an air layer over the part can be secured by the use of a thin waterproof covering in combination with a woollen covering.

After many trials, Dr. Delépine has succeeded in preparing very thin and soft oil-silk, which can be made into absolutely waterproof bags for covering any part of the body by means of apposition seams. They are light, inexpensive, and wear well, should be worn over an inner woollen sock, and be protected by an outside sock. With such a combination it is possible for the men to use the boots they have at present, provided they are two sizes larger than ordinarily worn. The oil-silk bags should extend up to the knee, and could probably be made for less than 3*s.* a pair. The importance of having nothing tight round the leg is obvious—the circulation in the part should be as free as possible, so that the circulating blood may maintain the warmth of the limb.

R. T. Hewlett.

[1] "On the Prevention of 'Frost-Bite' and other Effects of Cold." *Journ. Roy. Army Med. Corps*, May, 1915.

[2] *Lancet*, September 11, 1915, p. 595.

BRITISH BIRD BOOKS.

(1) TWELVE chapters on birds by the Hon. Mrs. Murray, which have for the most part already appeared in various magazines and journals, are now reprinted, and, under the title of "A Birdlover's Year," made to synchronise with the month of the year, although in some cases the subjects dealt with have nothing in particular to do with the month under the name of which we find them.

Grasshopper warbler. From "A Birdlover's Year."

In January winter birds are discussed appropriately in some half-dozen pages. In February we as naturally consider the song thrush and its travels, chiefly in the light of Mr. W. Eagle Clarke's "Studies in Bird Migration." April suggests the return of the birds, and May the birds as builders. There are pleasant summer sketches of a "Yellow-Hammer Lane" and bird-life of the hills; and autumnal ones on October bird-life and birds as travellers. The rest deal with ocean wanderers, Tayside summer visitors, gulls and terns, and hawks and falcons. The Rev. H. N. Bonar contributes thirteen pleasing photographs of bird-life, among which we may especially notice a lapwing preparing to brood her eggs, an excellent one of a common sandpiper on her nest, and another showing that shy and elusive bird, the grasshopper warbler, going on to hers. This must have been difficult to get, and the photographer is to be congratulated. The two last are here reproduced by permission of the publishers.

Sandpiper on its nest. From "A Birdlover's Year."

(2) Mr. Thorburn's beautiful bird-studies are so well known and greatly admired that the announcement of a new work on British birds by him, to be illustrated with coloured figures, was received with considerable interest and expectation by all those of the public who concern themselves with our native avifauna. Probably it was felt by many people that if an excuse could be put forward for the issue of yet another work on the subject, that excuse might well be found in the Thorburn illustrations. The first volume of the book is now in our hands, and we can see how far our anticipations have been fulfilled. We do not think that any disappointment will be expressed (but rather the contrary), although it is probable that the original studies were even more beautiful than the plates now before us. For the latter are apparently produced by some form of the three-colour process; and it is unfortunate that in this process one of the colours sometimes obtains undue prominence, and produces shades which were not intended to appear, and doubtless

[1] (1) "A Birdlover's Year." By G. G. Murray. Pp. viii+149. (London: Eveleigh Nash, 1915.) Price 3s. 6d. net.
(2) "British Birds." Written and Illustrated by A. Thorburn. 4 vols. Vol. i., pp. 148+19 plates. (London: Longmans, Green, and Co., 1915.) Price, 4 vols., 6l. 6s. net.

did not appear in the original drawing. But these slight and unavoidable lapses are in this case so few and so little noticeable that they do not detract in any appreciable degree from the beauty and accuracy of this charming series of pictures of our birds.

A characteristic of this work is that it aims at including every species of bird which has occurred in these islands. Other earlier works have done the same. But accidental wanderers, "new to the British list," occur here from time to time so frequently that a book soon gets out of date in this respect. Indeed, these additions to the British list have poured in at such an astonishing rate of late years, especially from one district in England, that Mr. Thorburn has had the opportunity of figuring, for the first time, as British, quite a large number of birds which have, many of them unexpectedly, appeared on our list. To have not merely a figure, but a beautiful coloured figure of all these will be most acceptable, especially to those who attach any great importance to these recent additions or many of them. At all events, we are all glad to know what they look like without referring to books perhaps not very accessible. Among those birds now painted for the first time as British we may mention the dusky thrush, black and pied wheatears, thrush nightingale, subalpine and Sardinian warblers, masked shrike, and collared flycatcher; and there are a good many others also. A number of birds are figured on each plate, and this, giving as it does an opportunity of comparing at a glance two or more nearly allied species, will be a great advantage to the beginner in ornithology and to those not far advanced in the study of British birds. And it is to these, we suppose, that the book will chiefly appeal, although there will be many past-masters in the art who will not be able to resist the desire to possess such a beautiful memorial of their favourites.

Some appropriate plants, flowers, and branches, introduced and skilfully blended in the plates, are instructive as to birds' habits, and greatly add to their beauty and effect. We may mention, for instance, the gorse blossom about the Dartford warbler and the stonechat, the rosemary on which the rufous warbler is perched, and the gentian by the side of the Alpine accentor; while a yellow crocus near the cock blackbird matches his orange bill. Most of the birds were drawn from life, and are the result of many years of studies of birds from the life with this object in view. To this we owe the remarkable success the author has had in catching the characteristic attitudes of the birds depicted. When it was not possible to obtain living birds for the drawings, the author has filled up the gaps from the best preserved specimens he could procure. Of the letterpress in this work it is not necessary to say much, because, as the author points out, being more familiar with the brush than with the pen, it was his first intention that the book should be simply a sketch-book of British birds practically without letterpress. But as the work proceeded he was induced to write a short description of the various species. Thus we have a condensed account of the distribution, nest and eggs, food, song, and general habits of each species. This letterpress is admittedly and of necessity largely a compilation, but the author has inserted, in addition to what has already appeared in print, such notes as he has been able to add from his own and his friends' observations.

So far as we can see from the present volume, the author may be congratulated on having produced the most accurate series of coloured figures of British birds (as such), as well as quite the most beautiful book on the subject, which has yet appeared. The publishers are also to be congratulated on the form in which it is issued. It is beautifully printed on really good paper, and the plain red linen-cloth cover with a gold line is just what we should desire. O. V. A.

SIR ANDREW NOBLE, BT., K.C.B., F.R.S.

SIR ANDREW NOBLE, the chairman and managing director of Sir W. G. Armstrong, Whitworth and Co., died on October 22 at his residence in Argyllshire. He was a great man of business, but what was more important to his country, a great scientific artilleryman. The story of his scientific work is, in fact, the history of the development of artillery in all its branches from the time of the Crimean War to the present date.

When Noble entered the Royal Artillery in 1849, after passing through the Edinburgh Academy and the Royal Military Academy, Woolwich, line-of-battle ships were all sailing vessels; the heaviest gun weighed 95 cwt., and fired a projectile of 68 lb.; rifled guns did not exist, and little or nothing was known of the principles of internal ballistics. This state of affairs was the opportunity for a clever, energetic officer with distinct scientific ability, and Noble was not long in forcing his way to the front. After serving for a short time with Sir Edward Sabine on the magnetic survey at the Cape, he became, in 1857, secretary of the Royal Artillery Institution, and wrote his first important paper, "On the Application of the Theory of Probabilities to Artillery Practice." He had in the meantime been appointed secretary to the Committee on Rifled Cannon, and it became necessary to ascertain the relative precision of fire of the various guns which came before the Committee for report. This he accomplished by calculating for each gun the area within which it was an even chance that any one shot would strike. He introduced the phrase "probable rectangle," which has been one of the commonplaces of artillery science ever since. The method adopted was naturally that of "least squares," but in applying this celebrated theory he showed much scientific intuition. He calculated separately the probable errors in range and deflection, and thence deduced the dimensions of the rectangle.

In 1859 Noble became secretary of the Com-

mittee on Plates and Guns, received the appointment of Assistant Inspector of Artillery, and entered the proof department of Woolwich Arsenal. Almost immediately after this he was made an associate member of the Ordnance Select Committee and a member of the Committee on Explosives. He was thus in closest touch with the burning questions that presented themselves for solution on the introduction of rifled guns. At this time (1860) the Government might possibly have secured his services for a further considerable period if they had promptly offered him a position suited to his growing reputation as a gunner of original ideas and untiring energy; but the Government acted too late, and a good offer found that he had already bound himself by contract to enter the Elswick firm as the director of its ordnance department. He, however, was retained on several Government committees, upon which his presence was invaluable, as he had the means at Elswick of carrying out many special researches, the results of which he freely placed at the disposal of the Government.

Noble's first important work in exterior ballistics appears to have been his experiments with the electro-ballistic apparatus of Navez, which had the object of making a close determination of initial velocity. He ascertained the causes which affect the velocity both with smooth-bore and rifled guns, and in particular he showed that with reduced powder charges the air-space in the powder chamber had a notable effect. He also discussed at length the law of dependence of the resistance of the air upon velocity in connection with previous researches of Probert, St. Robert, Mayevski, and Didion. The next paper, "On the Ratio between the Forces tending to produce Translation and Rotation in the Bores of Rifled Guns," was of much importance at the time it was written. Rifled guns were getting bigger every day, and there was much difference of opinion as to the best method of rifling and, in particular, as to the relative merits of uniform and increasing twist. He showed that with the uniform twist the force required to give rotation was only a small fraction of that required to give translation, and that in all cases the increment of gaseous pressure due to rifling was insignificant. With regard to the increasing twist (parabolic system of rifling) he also made a thorough mathematical investigation, and found again that the pressure on the studs due to rifling is only about 2¼ per cent. of the pressure required to give translation; also that the substitution of parabolic for uniform rifling reduces by about one-half the maximum pressure on the studs; and that the increment of gaseous pressure due to rifling, tending to burst the gun, is exceedingly small and less than that which obtains when the rifling is uniform.

His researches in interior ballistics properly so called commenced when he first went to Elswick, but the first publication appears to have been in the Proc. Roy. Inst. for 1871, "On the Tension of Fired Gunpowder." Previous investigators, de la Hire, Robins, Count Rumford, Cavalli, Neumann, Mayevski, Rodman, had obtained results for the pressure exerted by gunpowder fired in a closed vessel varying from 1000 to 100,000 atmospheres. Bunsen and Schischkoff later found 4374 atmospheres, about 29 tons on the square inch, for the pressure which the gases may approximate to but can never reach. Commencing in the year 1861, Noble, in conjunction with Sir W. Armstrong, carried out a large number of experiments, employing a chronoscope specially invented by himself. This beautiful instrument was able to measure a millionth of a second of time with ease. It was used in conjunction with a series of crusher gauges in determining the pressures exerted by the powder gases at various places along the bore extending from the powder chamber to the muzzle. The results were of first-rate importance. It was shown that the maximum pressure of fired ordinary gunpowder of unit density is not much above 40 tons to the square inch, but that in large guns, owing to the violent oscillations produced by the ignition of a large mass of powder, the pressure is liable to be locally exalted to an extent which endangers the endurance of the gun while detracting from the useful effect. It was also found that the intensity of this wave action is directly influenced by the position of the vent or firing point, and that it is desirable to have as short a powder cartridge as possible.

Noble's remaining researches in gunnery, extending over nearly fifty years, may be for the most part summed up under the title "Researches on Explosives." In these he was for many years associated with Sir Frederick Abel and Sir James Dewar. The objects in view were to ascertain the products of combustion of powders fired in circumstances similar to those which exist in guns—to ascertain the pressure exerted by the products of combustion at the moment of explosion and the law of its variation with the gravimetric density; to find the influence of the size of grain; to find the effect upon the products of a change in the pressure under which firing takes place; to measure the volume of the permanent gases liberated; to compare the explosion in a closed chamber with that in the powder chamber of a gun; to find the heat generated; and, finally, the work which the explosive is capable of performing on a projectile in the bore of a gun. That this lengthy programme was successfully carried out was largely due to Noble's extraordinary ability and energy. The results obtained were of the utmost importance to the manufacture of guns of all calibres. When fired in a closed space the temperature of the explosion of gunpowder was found to be 2200° C. The total work of gunpowder when indefinitely expanded was found to be 332,000 grm.-metres per gramme of powder, or 486 foot-tons per lb. of powder.

It is impossible in this short notice to say more upon these results, which are fully set forth in communications printed in the Transactions of the Royal Society between the years 1875 and 1879. The experiments were repeated as gunpowder gradually altered in physical characters,

and ultimately, when the cordite explosives were under consideration, a new set of experiments pointed out the modifications in gun construction that were necessary. It may safely be said that Noble threw light upon every question of internal ballistics. No doubt at Elswick he had very great facilities, but these would have been of no avail if he had not supplied practical knowledge and scientific insight, and supported these by his vigorous mind and untiring energy. It has been said that when a problem has been correctly stated, much has been already done towards its solution. When internal ballistics was in a state of chaos, Noble was able to extract the real questions from much that was irrelevant, and to give them a scientific statement. The result of his work has been that the splendid guns which we possess in the Navy and Army are at least as good as any in the world. It is certain that no history of gunnery will be complete which does not devote much space to a description of his pioneer work. That work was recognised on two occasions by the Royal Society: in 1870, when he was elected to the Fellowship, and in 1880, when he was awarded a Royal Medal.

P. A. M.

DR. R. ASSHETON, F.R.S.

BRITISH zoology, which recently sustained a severe loss by the death of Prof. Minchin, has received a second blow by the unexpected death of Dr. R. Assheton, which occurred at his residence, Riverside, Grantchester, near Cambridge, on October 24.

Dr. Assheton was born at Downham Hall in Lancashire in 1863, and belonged to an old Lancashire family. He was educated at Eton and afterwards entered Trinity College, Cambridge, where he came under the influence of the new school of embryology founded by Foster and Balfour and ably carried on by Sedgwick. He read for the Natural Sciences Tripos, in which he took first-class honours when he graduated in 1886. Thereafter he devoted himself to research in embryology, and was not long in making a name for himself. In 1889 he was appointed lecturer in zoology under Prof. Milnes Marshall in Victoria University, Manchester, and he held this post until Prof. Marshall's death in 1893. In 1901 he was appointed lecturer in biology to the medical school in Guy's Hospital, and took up his residence in Grantchester; he resigned this office in 1914 in order to give his whole time to teaching and research in Cambridge, where he was appointed lecturer in animal embryology. In the same year he received the well-merited honour of election into the Royal Society.

Assheton's earlier work was concerned with the difficult subject of mammalian embryology, and especially with the earlier stages of development and the beginnings of the placenta. He undertook a costly series of investigations into the early development of the sheep, and arrived at a novel view of the origin of the wall of the blastoderm vesicle from which the fœtal part of the placenta is principally derived. This he considered to be endodermic, not, as had always previously been believed, ectodermic. We think that this view is not adequately supported by the evidence which he adduced, and that it will scarcely survive. But Assheton did not by any means confine himself to mammalian embryology. The early stages of development of the frog, and the development of the curious Egyptian fish, *Gymnarchus niloticus*, also became the subjects of his researches.

From the very beginning of his work there was one feature by which Assheton was distinguished from most of his contemporaries. He was not content either with the simple description of developmental processes or with the search for their phylogenetic significance. In every case he endeavoured to analyse these processes into the differential rates of growth which underlay them, and then to find reasons for the differential rates of growth in differences of nutrition. He was, in a word, the first experimental embryologist in England. He succeeded in opening the hen's egg and keeping it still alive and developing for some days, and in this way he was able to watch the development of one and the same embryo, and by suitable tests to measure its growth. At a time when many embryologists were inclined to accept the view of His, that the nervous and skeletal axes of vertebrates were built up by the gradual concrescence of two lips bordering an elongated slit, Assheton was able to show that this view was an entire misinterpretation of the events, and to propound a solution which substituted for the alleged concrescence a growth in length of the embryo which he called *deuterogenesis*. All subsequent careful work has supported Assheton's view. Finally, in a paper entitled "The Geometrical Relation of the Nuclei in an Invaginating Gastrula (Amphioxus), considered in connection with cell-rhythm and Driesch's conception of entelechy," he measured swords with the "entelechy" of Driesch, and in substituting for that mystical factor a simple force which may well be of chemical or physical nature. At the time of his death Dr. Assheton was engaged in the preparation of a text-book of the embryology of mammalia. If this work was at all near completion it is to be hoped that it may be published, as otherwise a most valuable compilation of facts and a storehouse of illuminating ideas would be lost to science.

Dr. Assheton married a daughter of Sir Thomas Bazley, Bart., and is survived by his widow, one son, and two daughters. His son is serving as an officer in the 1st Cambridgeshire Regiment. He had a most charming personality which attracted all who knew him, and his loss will be deeply regretted by a wide circle of colleagues and friends.

E. W. M.

NOTES.

WE notice with deep regret the announcement of the death, on November 1, at sixty-seven years of age, of Sir Arthur Rücker, F.R.S., principal of the University of London from 1901 to 1908, and previously professor of physics at the Royal College of Science, South Kensington.

THE death is announced, on October 30, in his eighty-fourth year, of Lord Welby, president of the Royal Statistical Society, and for many years permanent secretary to the Treasury.

THE ninetieth illustrated Christmas course of juvenile lectures, founded at the Royal Institution in 1826 by Michael Faraday, will be delivered this year by Prof. H. H. Turner, his title being "Wireless Messages from the Stars."

THE director of the Meteorological Office reports that information has been received from the Seismological Observatory at Eskdalemuir, Scotland, of the record of a large earthquake which occurred at 7 a.m. on November 1, in or near Japan.

WE learn from the *Times* that the Nobel Prize for Medicine for 1914, of the value of about 8000*l*., has been awarded to Dr. Robert Bārany, professor of otology in the University of Vienna, for his work on the physiology and pathology of the vestibule of the ear. The prize for medicine for 1915 is reserved until next year.

PROF. KAMERLINGH ONNES announces in the *Nieuwe Rotterdamsche Courant* that he has received news from Vienna of the death of Prof. F. Hasenöhrl, professor of physics in the University of Vienna, who was killed in action on the Italian front. The deceased, who was a pupil of Boltzmann, began in 1899 an investigation on the dielectric constants of liquefied gases, in the cryogenic laboratory at Leyden. Having returned to Vienna, he became privat-dozent, and later succeeded Boltzmann, whose collected papers he edited with much care. Earlier in the war in Galicia, Prof. Hasenöhrl had been wounded in the shoulder, but after a complete recovery he again went to the front, where his lamented death occurred.

THE Naval Consultation Board appointed by national scientific and engineering societies at the request of the secretary of the U.S. Navy, has approved a plan for the establishment of a research and experimental laboratory for the Navy. It is recommended that the laboratory should be situated on tide water of sufficient depth to permit a "Dreadnought" to come to the dock. It should also be of complete equipment, to enable working models to be made and tested to destruction. The Board suggests that the investment for grounds, buildings, and equipment should total approximately 1,000,000*l*.; and the annual working expenses should be between 500,000*l*. and 600,000*l*.

A NOTE in *Engineering* for October 29 gives some particulars of the new monitors. Without accepting as technically accurate the somewhat picturesque details published in official accounts, it may be assumed that the Admiralty designers have succeeded in producing vessels with the heaviest of guns which are practically immune from torpedo attack. Some mount 14-in. guns in a central turret, others have one 9·2 in. bow and one 6-in. stern guns, and others, again, two 6-in. guns. The 14-in. guns fire projectiles of ¾ ton weight, and the range is 15 miles. Our 6-in. gun "throws 100 lb. of high explosive 12 miles without overreaching itself." The vessels are not of great speed—this is not required. Only six months elapsed from the time that the demand for their design was made until they fired their first shot. It is a great credit to all concerned, notably to the workmen in the shipyards, that this need was so promptly met.

THE *Morning Post* of November 2 publishes the following message from its Paris correspondent referring to the close relations now possible between science and the French Army:—By becoming Minister of Public Instruction and Inventions Affecting National Defence in the new French Cabinet, M. Painlevé will, it is hoped, be able to place the inventive skill of the nation more directly at the disposal of the Ministry of War. He has served for a considerable period as President of the Inventions Committee, and during his tenure of that office it became evident to him that every effort ought to be made to organise scientific skill and to co-ordinate effort. In his new capacity he becomes the sole intermediary between the world of science and the Army. Under the system now established one of the ways in which the Ministry will be useful to the country is that it enables the Army whenever the need arises to appeal directly to men of science for the solution of any scientific problem.

THE name of Dr. Philippe Hatt, whose death, at the age of seventy-five, we regret to announce, will be more familiar to the astronomers of the last generation than to those of the present. In the middle of the last century, when Government expeditions for scientific purposes were frequent, M. Hatt rendered good service. He organised and took part in the French Expedition to Wha Tonne, in the Malay Peninsula, where the eclipse of 1868 was successfully observed by Rayet, Tisserand, and others. 1874 found him on the bleak, inhospitable rock known as Campbell Island, to observe the transit of Venus. With André he went to the Rocky Mountains for the observation of the solar eclipse of 1878, and four years later he had a prominent place in the French Expedition to Chubut to observe the second transit of Venus. Less sensational, but equally meritorious, work M. Hatt achieved in the course of his professional career as a hydrographic engineer. So far back as 1866 he was entrusted with the task of making a new survey of the coast of Cambodia, and the lower course of the River Saigon. At the time of the French annexation of the country he explored the Gulf of Siam, and demonstrated the value of Gahn-Ray Bay as the site of a commercial port. Later he devoted himself to hydrographic work on the French coast, to the triangulation of Corsica, and the observation of tidal phenomena, concerning which he produced some valuable memoirs. He was elected in 1897 a member of the French Academy of Sciences, in the section of geography and navigation, in succession to M. Antoine d'Abbadie.

It is claimed that a Swedish engineer, M. Wulff Normelli, has invented an ammonium nitrate explosive, Normellite, which has a bursting effect 25 per cent. better than that of any other explosive. It is claimed also to be safer than most explosives, being very insensitive to shock. This latter is characteristic of ammonium nitrate explosives, which require a powerful detonator, and frequently a priming of the loose explosive. Since Favier took out his patents in 1884-85 for an ammonium nitrate powder containing naphthalene, paraffin, and resin, very many explosives of this class have been introduced. The hygroscopic nature of the salt necessitates enclosing the explosive in some waterproof envelope. On account of the low temperature on firing and the production of little or no flame-producing gases, this class of explosives is particularly favoured for use in fiery coal mines. With the nitrate all kinds of combustible materials are employed, such as di- and tri-nitrotoluene, dinitronaphthalene, charcoal, etc. Other nitrates are frequently substituted for a portion of the ammonium nitrate. Roth in 1900 took out patents for the use of aluminium powder in such explosives, the idea being to utilise the high temperature attained by the oxidation of this metal, and thus greatly increase the power. Ammonal is such a mixture, containing, in addition to the nitrate and aluminium, trinitrotoluene and charcoal. It has been claimed that ammonal is a very powerful explosive, and is more effective than a similar weight of cast picric acid (lyddite) in breaking up a shell. It is therefore not improbable that Normellite is an explosive of similar type to ammonal.

The council of the Chemical Society has sent to every fellow a letter directing attention to the Government scheme for the organisation and development of scientific and industrial research. In accordance with this scheme, a Committee of the Privy Council has been appointed, and also an Advisory Council of scientific men whose primary functions are to advise the Committee of Council on—(i) proposals for instituting specific researches; (ii) proposals for establishing or developing special institutions or departments of existing institutions for the scientific study of problems affecting particular industries and trades; (iii) the establishment and award of research studentships and fellowships. The council of the Chemical Society considers it to be the urgent duty of every fellow to render all assistance possible to the Advisory Council by suggesting suitable subjects for research. As pointed out in the White Paper, the results of all researches financed by public funds will be made available under proper conditions for the public advantage, and the council feels assured that every fellow will place patriotic duty before private gain at such a time. Suggestions for purely scientific researches will be appreciated, but those having a direct bearing on chemical industry and its promotion will naturally receive a preference. Suggestions should be sent to the council of the Chemical Society, Burlington House, W.; those suggestions which are considered suitable to receive the financial aid indicated by the scheme will be forwarded to the Advisory Council.

The committee which was constituted last year to promote testimonials to Profs. Perry and Harrison on their retirement from the staff of the Imperial College (Royal College of Science) has now completed its labours. We are informed that in each case there was a gratifying response to the appeal to former students and colleagues for subscriptions, and that the committee has thereby been enabled to carry out its purposes completely. The testimonial to Prof. Harrison, who had been associated with the department of mathematics and mechanics during thirty-two years, has taken the form of an illuminated address, accompanied by valuable personal gifts. In the case of Prof. Perry, former students of the Finsbury Technical College desired to be associated with the testimonial, in recognition of his valuable services to that institution prior to his joining the staff of the Royal College of Science in 1896. The governing body of the Imperial College having readily consented to act as trustees, the aim of the committee was to establish a permanent memorial of Prof. Perry's work in the form of a medal or prize to be awarded annually at each of the two institutions. In view of Prof. Perry's desire that the testimonial should not include a personal gift, the whole of the subscriptions became available for the founding and endowment of medals. Dies have been prepared from designs by Mr. Charles Wheeler, of the Royal College of Art, and these, together with a stock of medals, and a certificate for 4½ per cent. War Loan Stock, have recently been placed in the custody of the Imperial College. A silver medal will be awarded annually to a student of the Imperial College for distinction in mathematics and mechanics, and at the Finsbury College a similar award will be made for distinction in mathematics and engineering. The governing body has expressed its high appreciation of the committee's decision in associating the Perry medal, and the administration of the fund, with the Imperial College, and has stated that the gift is regarded as a fitting testimony to the inspiring personality of one who took such a prominent part, both in the Royal College of Science and in the Imperial College, in the teaching of mathematics and mechanics. Prof. Perry has also expressed his gratitude for the honour which has been conferred upon him by the subscribers, and by the Imperial College. The obverse of the medal is a striking portrait, and a plaster copy of the original large model has been presented to Prof. Perry.

The report of the Government Museum at Madras for 1914-15 is a record of steady progress. The pre historic collections of Mr. R. Bruce Foote have been rearranged, and the Hindu, Buddhist, and Jain sculptures, which include an important collection from the Amaravati Stupa, have been classified. Considerable stores of Roman coins which are being discovered year by year, including those of the Emperors Nero, Trajan, and the Empress Faustina, illustrate the important trade intercourse between Rome and southern India in the early period after the Christian era.

The Museum Journal of the University of Philadelphia for March, 1915, but only recently received, is

almost entirely devoted to an account of the expedition under Dr. Farabee, which has now been nearly two years in the field. His first journey had for its object the exploration of the boundaries of Venezuela and Brazil. He then visited the Macusi tribe in southern British Guiana, a most perilous undertaking. He next started for the upper waters of the Amazon and conducted archæological investigations on the island of Marajo, near the mouth of the river. From there he again proceeded to the Upper Amazon. Large ethnological collections have been made, but these cannot be fully examined until the expedition returns to the United States. Meanwhile this preliminary report, illustrated by a fine collection of photographs, is of much interest.

HIS HONOUR JUDGE J. S. UDAL contributes to the September issue of *Folk-lore* an interesting account of the practices connected with what is known as the Obeah cult in the West Indies. These include the worship of the criboe, a large black, non-venomous serpent, and some ghastly rites of human sacrifice. It has been asserted by some writers that these practices have now ceased, but Mr. Udal has collected a large mass of evidence from law proceedings and other authoritative sources to prove that this is not the case. He ends by expressing the hope that "now that the consciences of the public of our West Indian colonies and of the Home Government have begun to realise to what terrible lengths any indulgence towards or weakening in the repressive enactments against this widespread plague of Obeah may lead, that we shall see the rapid disappearance of any objectionable features in its cult, leaving only, it may be, a harmless residuum that may still afford some interest to the student and lover of folk-lore."

THE *Psychological Review* (vol. xxii., No. 4) contains an interesting summary of an "Experimental Investigation of the Subconscious," by Miss L. J. Martin. In view of the great interest now being shown in the treatment of mental diseases by psychological means, any method which enables the physician to penetrate below the threshold of consciousness is at least worthy of consideration. The Freudian technique of psycho-analysis requires a long training, and even so, is open to various objections. Hypnotic methods are not always possible or suitable. Miss Martin claims that the "image" method has certain definite advantages over the methods usually adopted for tapping the subconscious.

AN article on "Variability in Performance during Brief Periods of Work," which appears in the *Psychological Review* (vol. xxii., No. 5), has some bearing on a problem of great moment at the present time. Investigations into the conditions of, and remedies for, industrial fatigue are now occupying the attention of a committee of the British Association, and any contribution to the processes involved in work of any nature may be significant. This paper shows that an individual varies in the success of his performance of given tasks even though these last but one minute. The authors, as a result of their experiments, think it probable that mental fatigue is not as rare as is sometimes supposed, but that the repair process is so rapid, compared with muscle repair, that, as work is usually done, the loss may be compensated for during brief intervals of relaxation.

THOSE responsible for the care of museums will welcome the "General Guide to the Collections in the Manchester Museum," which has just been published by Messrs. Longmans, Green and Co. at the modest price of 3*d*. It is a model of what such guides should be, and is admirably illustrated. Perhaps its most interesting section is that on Egyptology, which contains a tabular statement of the various periods of Egyptian history from the pre-dynastic to the Roman, with the dates of each according to Petrie and Breasted.

DR. J. M. DEWAR, in the *Zoologist* for October, continues his notes on "The Relation of the Oyster-catcher to its Natural Environment," discussing, in this section, the summer environment. Though, during most of the year, a dweller by the seashore, this species shows a marked preference for an inland breeding-place. The area chosen by Dr. Dewar for his observation station is typical of its kind, and his notes should be carefully read in comparison with the accounts which have been given of the reproductive period of individuals which, perhaps for lack of suitable inland stations, establish their nurseries by the seashore. This number also contains same interesting notes by Mr. G. T. Rope on the vagaries of choice displayed by cats in the matter of diet, citing numerous instances where earthworms, fungi, raw potatoes, baked pears, tomatoes, cucumbers, and marrow-seeds were preferred to a meat diet.

A VALUABLE summary on the "Status, Plumages, and Habits of the Wren of St. Kilda," by Mr. W. Eagle Clarke, appears in the *Scottish Naturalist* for October. The St. Kilda wren is one of the most interesting of the five-and-twenty endemic species now recognised by the British Ornithologists' Union, and though made known more than thirty years ago, this is the best account yet given of its habits, plumages, and relation to environment. In the same issue Mr. William Taylor records the "History of the Triassic Reptile *Scleromochlus taylori*." Dr. A. Smith Woodward, it may be remembered, some years ago expressed the opinion that this very fragmentary fossil should be regarded as a diminutive bipedal dinosaur, with a jerboa-like mode of locomotion. Baron von Huene now comes to the conclusion that it was not a crawling, walking, or jumping animal, but that its short, spreading hands and long feet show it to be well suited for climbing trees, and that it may have possessed some kind of flying membrane, recalling the bat in this respect. On the whole, we incline to think Dr. Smith Woodward's view is much the more probable.

IN Bulletin No. 20 of the Department of Agriculture, Ceylon, on "The Effect of Different Intervals between Successive Tappings of *Hevea brasiliensis*." the interesting conclusion is reached that after five years' continuous tapping there is no evidence that the yield obtained in a given time by tapping at an interval of five or seven days will ultimately exceed that obtained by more frequent tapping.

THE recently issued part (part i., vol. vi.) of the Annals of the Royal Botanic Gardens, Peradeniya, is almost entirely occupied by a series of papers by Mr. T. Petch, the Government botanist. Of these the most important contribution is that on "Horse-hair Blights," belonging to the genus Marasmius. *M. equicrinis* is the common species of the eastern tropics, while *M. sarmentosus* is the species found in the West Indies. Mr. Petch devotes his attention to the Ceylon species, which are described in some detail and illustrated by an excellent series of plates. The mycelium of these fungi is thin and rhizomorphic, and spreads freely over bushes and trees at some height above the ground; the pileus is borne on a slender petiole, and bears only a small number of gills.

A COLLECTION of fungi from Australia and New Zealand made by Mr. W. N. Cheeseman during the visit of the British Association to Australia and New Zealand last year is described by Miss E. M. Wakefield in Kew Bulletin No. 8. Twenty-eight of the 100 species enumerated are endemic to Australia, and these include the seven new species described. Five of the new species show close affinity with European or North American types. Forty-eight species were found to be common to Europe or North America, sixteen to the tropics of Africa and the East, and six cosmopolitan in the tropics generally. Only two species occur in the tropics of South America as well as in Australia. Attention was paid especially to the Polyporaceæ and Thelephoraceæ, and the collection consists mainly of specimens belonging to these groups. The principal features of the new species are illustrated in the plates.

Symons's Meteorological Magazine for October gives some very interesting details on the rains for September, which varied considerably in different parts of the British Isles. The rainfall table shows an excess of rain in parts of Scotland and in the south-east of England, whilst elsewhere there was a deficiency. At Gordon Castle the excess for the month amounts to 3·17 in., the fall being 222 per cent. of the average, whilst at Seathwaite the deficiency for the month was 9·20 in., the fall being only 18 per cent. of the average. A special article is given on the floods in the north-east of Scotland which occurred in the closing week of September, when the floods are stated not to have been equalled in many districts since the famous Moray floods of August, 1829. The area of maximum rainfall was located on the shores of Moray Firth, near Inverness, the fall for the twenty-four hours on September 25 being 4·07 in. at Fortrose, 3·78 in. at Nairn, and 3·64 in. at Inverness. The total fall for the three rain days September 24, 25, and 26 amounted to 5·47 in. at Nairn, the rain really falling in about forty hours. The river at Nairn overflowed its banks and occasioned much damage, whilst sixteen bridges and culverts were carried away. The Daily Weather Charts issued by the Meteorological Office show very distinctly the advance and movement of the cyclonic disturbance which occasioned the rainfall, the central area being situated over the south of Scotland on the morning of September 25. The rainfall in the south-east of England on September 29, which caused an excess for the month, was due to the passage of a cyclonic disturbance along the English Channel, and centred over the Straits of Dover on September 29.

AN interesting account of attempts to improve the somewhat primitive methods used in certain of the native industries of India is found in a paper by Mr. A. Chatterton, in Bulletin No. 55 of the Agricultural Research Institute, Pusa. It deals with the manufacture of jaggery in South India, and gives an account of experiments made to introduce power-driven sugar-cane mills as a substitute for the bullock-driven mills hitherto universally used. A description is also given of improvements in methods of evaporation introduced with the object of increasing the yields obtained from the juice; with the existing wasteful methods these are far lower than they should be.

THE October number of the Journal of the Röntgen Society contains the interim report of the committee on the standardisation of X-rays when administered for medical purposes. It mentions most of the methods of determining the quality or hardness and the intensity of the X-rays falling on a surface, with the intention of providing a proper basis for a more extended discussion of the relative merits of the various methods at a later date. On the whole the report seems in favour of the half-value method of determining quality. The rays are sent through a stepped wedge of a standard material—generally bakelite—and fall on a fluorescent screen. Beside the wedge is placed a metal plate with holes through it which remove half its material, and the step of the wedge which gives, on the screen, the same intensity of image as the metal plate is noted. For determinations of intensity the report apparently approves some form of ionisation method, as most of the other methods give undue weight to the softer rays.

AN important paper on the theory of grinding was read at the Institution of Mechanical Engineers on October 15 by Mr. J. J. Guest, of Birmingham. Apart from side issues, the speed limit of the grinding wheel is controlled by the strength of the material of the wheel, and for reasons of production the wheel is to be used at the highest safe surface-velocity. The author considers that the component of the work-velocity which is normal to the wheel surface (termed the "normal material velocity") is the fundamental controlling factor. This velocity is given by

$$v_1 = v\sqrt{2t\frac{d+D}{dD}},$$

where v is the surface velocity of the work, t is the reduction in diameter being effected, and D and d are the diameters of the wheel and work respectively. This quantity, as has been said, is the controlling factor, and if it is too large the wheel will wear unduly, while if it is too small the wheel will glaze. Again, the work done in grinding off metal is proportional to the volume removed, *i.e.* the rate of grinding, $\frac{1}{2}vtc$, depends on the power used, c being the traverse. vtc cannot exceed a certain amount, b, and for production reasons should be kept up to that amount, hence $vt = b/c$, together with the above

equation, will serve to determine the values of v and t for any particular case, and are sufficient for the purpose. The author gives several numerical applications of this theory, which appears to be of general application in the selection of speeds in plain and internal work.

THE *Engineering Magazine* for October contains an article on the forests of the United States, by Mr. Leonard Lundgren. Before the coming of the white man these forests covered an area of about 800 million acres, and contained about 5200 billion board feet of lumber. Fire has destroyed as much timber as has been utilised for industrial purposes, and as much again has been wasted through poor logging and milling operations, and through clearing land for agricultural purposes. The forests at present cover an area of 550 million acres, and contain about 2900 billion board feet of lumber. Seventy-six per cent. of this is owned privately, 21 per cent. is held by the United States in the national forests, and 3 per cent. is on other public lands. The annual cut is approximately 43 billion board feet; at this rate, if there were no new growth and the present demand were maintained, the timber supply would last about sixty-five years. It is reasonable to expect that all agricultural lands, cultivated or uncultivated, will ultimately be placed under crops that will give the greatest economic return. Some of the lands now under cultivation will unquestionably revert to forest. Through reducing the per capita consumption (at present amounting to 260 cubic feet of wood per inhabitant), protection against fire, and increasing the natural growth per acre by the practice of forestry, it is probable that a balance between production and consumption will eventually be reached by the force of natural economic laws. In Saxony, where forestry has been practised for many years, the annual production is 93 cubic feet per acre. Forestry is practised in the United States on Government and State lands only, and the estimated annual production is 12 cubic feet per acre.

MESSRS. CONSTABLE AND CO., LTD., 10 Orange Street, London, W.C., inform us that they now publish in this country, at 6s. 6d. net, Prof. L. T. More's "The Limitations of Science," reviewed in the issue of NATURE of September 2 last (vol. xcvi., p. 3).

OUR ASTRONOMICAL COLUMN.

THE ANDROMEDA NEBULA.—According to a notice in the September Journal of the Royal Astronomical Society of Canada, a determination made at Mount Wilson of the radial velocity of this nebula indicates a recessional motion of 329 km./sec. from measures of nine lines. The spectrogram was obtained on five consecutive nights during last November (thirty-four hours' exposure), by means of a small slit spectrograph at the primary focus of the 60-in. reflector. There is stated to be no evidence of either bright lines or rotational displacement.

A LONG-PERIOD SPECTROSCOPIC BINARY.—Mr. J. B. Cannon has made a determination of the orbital elements of μ Persei, a spectroscopic binary having the somewhat long period of 284 days. The spectrum is of the solar type, and a number of lines being available for measures, a good determination of velocity could be made. Forty-eight plates secured during 1913–15 were measured, and combined to give 0·11 normal places, the velocity-curve coming out very nearly symmetrical. A range of velocity of 41 km. is indicated, whilst 39 km. was found from seven Lick spectra.

SUN-SPOTS AND TEMPERATURES.—In continuation of the statistical investigation of the question of seasonal variations of weather Dr. Gilbert T. Walker publishes (Memoirs of the Indian Meteorological Department, vol. xxi., part xi., p. 61) a paper giving the correlation coefficients of sun-spots with temperature for a large number of stations generally distributed over the earth's surface. A paradoxical defect of temperature associated with times of maximum sun-spots is revealed for a large number of stations, more especially tropical. An area of positive coefficients, however, stretches from the Arctic over the western parts of Europe.

THE UNION OBSERVATORY.—Circulars Nos. 26 and 27 have recently come to hand. The first of these gives details in continuation of the investigation by blink-microscope of the variable stars in the region of η Argus. A table is given showing the results of special search for known variables not picked up in the first survey. The variability of a star (R.A. 10h. 9m. 36s., declination $-58°$ 24·3′ (1875), announced last year by Dr. A. W. Roberts, is confirmed.

In the other circular Mr. J. Voûte gives the results of measures of sixty-seven double stars, employing the Bosler-Salet inverting prism to eliminate systematic errors in the measurement of position angles. The instrument used was the 9-in. Grubb refractor. It was specially desired to obtain experience of the working of the method under additional instrumental conditions in extension of measures made at Leyden and at the Cape. In this process the position-angle is determined as the mean of measures made before and after inverting the field by means of a prism. The present results are in good agreement with the Leyden series, amply supporting the favourable opinions regarding the method.

A message from the observatory, dated October 7, informs us that a 12th magnitude star, with a proper motion of 5·1″ a year, has been found with the blink apparatus. Full particulars will be given in a forthcoming Union Observatory Circular. The place of the star is (1900) R.A. 14h. 22·9m., declination $-62°$ 2′.

THE ORBIT OF B.A.C. 5890.—A noteworthy spectroscopic investigation of this binary system has been made by Mr. F. H. Parker at the Dominion Observatory, Ottawa (*Jour. Roy. Astr. Soc.*, Canada, September). The reductions are based entirely on pairs of measures made on plates showing spectra of both components. Nineteen such plates were secured at Ottawa, but the dispersion only sufficed to separate the lines near primary maximum. However, one of three Lick spectra showing double lines was taken near apastron, thus fortunately bridging the gap. The measures of the Canadian plates were grouped into five normal places, those from the Lick plates giving three additional points. The photographic magnitude of the star is 4·9, the spectrum being of the F type, and the lines are described as "broad." The masses of the components are very nearly equal (25 : 24). The period is 26·27 days, whilst the eccentricity has the rather large value 0·49. This is not altogether exceptional, for, curiously enough, binaries having periods 12–30 days yield an average value of 0·462, according to the data recently collected by Dr. Sven Wicksell.

IRON AND ALLOTROPY.

MANY points of theoretical interest as well as of practical importance were brought forward in the discussion "On the Transformation of Pure Iron" opened by Dr. A. E. Oxley, of the University of Sheffield, at the Faraday Society on October 19. The subjoined summary describes the main views presented.

It is now believed by many metallurgists that the A_2 transformation of iron can be explained without assuming allotropic change, but the A_3 transformation is regarded as involving allotropy. The crystalline state is one of extreme molecular association (physical polymerism or the grouping of chemical molecules under the influence of mutual physical forces), and if allotropy is determined solely by the nature and extent of this association each substance will show an unlimited number of allotropic forms within a finite temperature interval. On this view the attempts to show that A_3 involves allotropic change while A_2 does not, need not have been made.

To surmount the difficulty presented by the existence of so many allotropes, two different types of allotropy have been recognised: (1) the two-phase (discontinuous) type, (2) the one-phase (continuous) type. Having adopted these, we have now to determine experimentally to which type a given transformation belongs. The burden is thus thrown on our experimental refinements, and the difficulty of drawing a sharp distinction is at once apparent—the distinction can only be arbitrary. In this connection the liquid crystalline state is interesting. There are some substances which show no liquid crystalline state on fusion, but do so prior to recrystallisation. Thus we have two-phase allotropy on heating and one-phase allotropy on cooling.

Defining allotropy as a difference of atomic structure of the chemical molecule (consistent with the transformation from oxygen to ozone, or from one isomer to another), a distinction can be drawn between allotropy and crystalline grouping. Allotropic modifications will form characteristic space lattices determined by their molecular constitutions. It does not necessarily follow that a difference of crystalline symmetry implies allotropy, for *identical* molecules can be packed together in different ways (Barlow and Pope, Trans. Chem. Soc., vol. lxxxix., p. 1741, 1906). We must distinguish between the forces holding the molecules in a definite space lattice and those holding the atoms in the molecule.

Now on the theory of the molecular field Weiss has shown (*Comptes rendus*, vol. cxliv., p. 25, 1907) that the so-called β and γ forms of iron have the same Curie constant, and A_3 is not an allotropic change point. In a later research (*Journ. de Phys.*, vol. I., p. 965, 1911, and *Arch. des Sciences*, 1913), using more recent data, ***and assuming that each atom possesses an integral number of magnetons***, Weiss shows that the transition β to γ may be represented by a change from a tri-atomic to a di-atomic molecule. If, however, the magnetic particle of the γ state consists of three molecules, and that of the β state of two molecules, the magneton theory will still hold, but now the number of atoms in a molecule of each state is the same. This latter view seems more probable, for γ iron possesses more magnetons per molecule than β iron does, and therefore unless we suppose that the molecules of the β state are so bound together that one cannot rotate without dragging along its neighbours, it seems difficult to account for the rapid increase of susceptibility on cooling through A_2.

If cooling through A_2 is accompanied by a closer grouping of the molecules in the direction (characteristic for each crystal) of spontaneous magnetisation, there will be no change of crystalline symmetry, while the increased interaction of the molecules will give rise to ferro-magnetism. The change of molecular distances in the perpendicular directions is not important from a magnetic point of view, each molecule being mainly constrained by the one in front and the one behind in the direction of the magnetic axis. (Silver iodide (hexagonal) is an example of a crystal which expands along the axis while contracting in perpendicular directions.) Thus this interpretation is not necessarily inconsistent with known magneto-striction data or with determinations of thermal expansion (linear or volume) of a *mass* of iron crystals.

The thermal evolution at A_2 is due to the readjustment of molecular distances. The rise of temperature observed is 14° C. (Arnold, B.A. Report, Sheffield, 1910), and taking 0·1 as the specific heat of iron, the thermal evolution is 1·4 cals./gram. This value is small compared with the latent heat of fusion of elements, *e.g.* P (5), Bi (13), Cd (14), Pb (5), Ag (22), Sn (14), Zn (28), Ga (19). Further these latent heats are in general small compared with the thermal evolutions in known allotropic and isomeric transformations. Thus

Allotropic	96 gr. ozone = 96 gr. oxygen + 59,200 gr. cals. 31 gr. yellow phosphorus = 31 gr. red phosphorus + 21,000 gr. cals.
Isomeric	78 gr. dipropargyl = 78 gr. benzene + 100,000 gr. cals. 58 gr. allyl alcohol = 58 gr. acetone + 18,600 gr. cals. = 58 gr. propaldehyde + 22,600 gr. cals.[1]

The transition $2O_3 \longrightarrow 3O_2$ has the thermal value +600 cals./grm. The transition $\beta \longrightarrow \gamma$ in iron has the thermal value −1·4 cals./grm. Can we regard this latter transition as $2Fe_3 \longrightarrow 3Fe_2$?

The small thermal evolution at A_2 favours the view expressed above that the transformation involves a molecular regrouping, similar to that occurring in the ordinary process of crystallisation, rather than a rebuilding of the atomic structure of the molecule. Hitherto we have not considered a change within the atom itself, such as a variation of the electric or magnetic elements. Some such change must occur in the iron atom, as it enters into different chemical combinations, otherwise how can we explain why iron carbonyl, $Fe(CO)_4$, is diamagnetic, while ferrous chloride, $Fe(Cl)_2$, is strongly paramagnetic? Do we not here have a kind of atomic allotropy? In this sense the allotropic theory may be consistent with the carbide theory which attributes the properties of carbon-steels to definite compounds of iron with carbon (such as cementite (Fe_3C)). Magnetic phenomena appear to be so definitely related to the atom that the existence of different types of iron atom is suggested inevitably, and the suggestion would not be at variance with modern views of atomic structure. Many arrangements of electronic orbits in dense atoms are theoretically possible.

The work of Prof. W. H. and Mr. W. L. Bragg must be considered in relation to any phenomenon of crystals. They have shown the difficulty, even in ordinary cases, of even defining the molecules of the crystals, although in many cases this is possible. But to determine by their method whether, in an iron crystal, any atom has a *special* relation to one of those surrounding it, would be nearly impossible. The optical effects which they investigate are determined only by the nucleus or core of the atom, and the outer arrangements in the atom, determining its allotropic forms, might differ considerably without being capable of detection except perhaps by their magnetic properties. On these lines, therefore, no immediate objection to the existence of such different types of atom

[1] *Vide* Muir and Wilson, "Elements of Thermal Chemistry," pp. 250–53, for many other examples.

can apparently be raised, and the suggestion of atomic allotropy appears worthy of development as a possible interpretation of others among the phenomena of pure iron, which considerations of space have excluded from the present summary.

During the discussion several interesting slides showing variations of the micro-structure of iron were exhibited by Prof. H. C. H. Carpenter.

PREVENTIVE MEDICINE IN PENNSYLVANIA.[1]

PREVENTIVE medicine is a science so likely to appeal to the genius of the American people that it is of considerable interest to read the reports issued in July, August, and September of 1914, by the Pennsylvania State Department of Health on various aspects of its activities.

As elsewhere, so in the State of Pennsylvania, the force which caused the development of preventive medicine was the compulsion exerted by outbreaks of disease. An epidemic of typhoid fever in 1885 was the means of obtaining the enactment of a previously twice defeated Bill to establish a State Board of Health, which, however, at first was much circumscribed in its powers and duties. A severe outbreak of smallpox in the years 1901–04 impelled the Legislature to establish a State Department of Public Health.

At its head is a Commissioner of Health, with very great powers of initiative, on whom falls the duty of appointing whatever assistants he may find necessary to carry on the work. The State Department of Health has direct executive control over all public health problems of every sort in the more rural portions of the State, comprising four-fifths of the land area and one-quarter of the total population. Over the remainder of the population, aggregated in the more densely populated townships, which are required to maintain their own local boards of health, the State Department of Health has advisory and supervisory control, but no executive responsibility except in relation to sanitary engineering, tuberculosis, and the collection of vital statistics.

The State administrative machinery, therefore, in some respects resembles, but in others is in marked contrast to, that of an English county health department. Both have general supervisory and advisory duties with regard to the smaller areas within their compass. The English county department has, however, nothing approaching to the wide general executive functions of the Pennsylvania State Department, although in some respects—for example, in the control of tuberculosis—their activities are akin. The complete responsibility of the Pennsylvania State Department for the health of the public in the rural portions of its area has no analogy in county administration in this country. The English system is based far more than is the Pennsylvanian on local as opposed to central administration.

The organisation of the State Health Department would appear to be on very effective lines. Out of the central department have crystallised a number of sub-departments, or divisions, dealing respectively with vital statistics, school medical inspection, sanitary engineering, tuberculosis dispensaries and nursing, sanatoria, housing, laboratories, and the distribution of biological products. The chief of each division reports directly to the health commissioner. There are two special divisions, one of which conducts all the auditing and accounting and part of the purchasing for other divisions, while the other attends to the whole of the storage and shipment of materials. The divisional executive officers are thus left free to devote their energies to the more essential public health work.

1 Pennsylvania Health Bulletin, July, August, September, 1914.

Comparison of the work of some of these divisions with that of health departments in this country is instructive. For example, the registration of births and deaths is far more closely bound up with public health in Pennsylvania than is the case in England and Wales, in which it is not in any way directly controlled by the Health Department; whereas in Pennsylvania, on the contrary, the Division for Vital Statistics, a branch of the State Health Department, under the direct supervision of a health officer, is responsible for precisely the same work as is done by our local and central registrars in respect of births and deaths and marriages.

In the same way the school medical service, instead of being, as is unfortunately the case in this country, a separate service affiliated only for reasons of convenience to the public health service, is recognised in Pennsylvania as essentially a branch of public health, and as such is administered by the State Health Department through a division of medical inspection. Sanitary engineering, again, carried out as it is by a special division of the State Health Department, is much more clearly recognised as a function of public health than is the case in this country.

Perhaps the most striking feature of the Pennsylvanian scheme is its systematic educational campaign. All reports sent in from every division of the Health Department to the Health Commissioner are dealt with from their public health aspect, and are then handed over to an educational section of the central department, where they are rewritten and issued in popular form as lectures, circulars, leaflets, newspaper talks, or periodical bulletins. This eagerness to popularise technical knowledge is an important side of public health work, which could with advantage be better developed in this country. In general administration, probably English methods give as good results, though possibly in more circuitous ways. Pennsylvania has had the advantage of beginning at a time when it could develop its public health system at one stroke and as a whole, and so could largely avoid the errors and vagaries of a system which has grown by accretion.

H. P. N.

CHEMISTRY AT THE BRITISH ASSOCIATION.

ALTHOUGH so many topical subjects were, on account of the war, excluded from the discussions of the section, the attendance at the meetings was on the whole satisfactory, exceeding the anticipations of the earlier part of the year. It is, however, clear that anything like general interest can only be evoked in the Chemical Section by discussions on rather broad subjects, papers giving the results of researches on some particular branch being only too frequently delivered to nearly empty benches. This not infrequently arises from the paper being so specialised that the author is practically the only person in the room capable of appreciating its significance and value. One cannot help feeling that the atmosphere of the Chemical Society or other specialised body would be more sympathetic. Under the exceptional circumstances of this year foreign guests were few in number, but the section had the pleasure of welcoming and listening to two of our Belgian allies—Prof. Henry and Prof. Ranwez, from Louvain, the former giving an account of researches on the preparation and properties of vinylacetic nitrile, which he has carried out in Prof. Perkin's laboratory at Oxford during his residence in this country, while the latter contributed a paper to the discussion on smoke.

The section met on three mornings and two afternoons, so that although the whole meeting was shorter than has hitherto been customary, chemists actually devoted more time to the consideration of their subject, and the usually rather risky experiment of afternoon sessions proved entirely successful, chiefly no doubt because social counter-attractions were absent.

Two mornings were occupied by discussions, one dealing with smoke and its prevention, the other with homogeneous catalysis. Manchester, to the residents in the rural parts of these islands, shares with Sheffield an unfortunate reputation for griminess; therefore the discussion on smoke was peculiarly apposite. Though many efforts are made to combat the smoke evil, not only because of its noxious effects, but also because of the enormous waste due to the huge quantities of valuable fuel constantly being poured into our atmosphere, much still remains to be done towards the economic utilisation of our fuel supply. The discussion was opened by Mr. E. D. Simon, chairman of the Manchester Air Pollution Advisory Board, with a paper on "Lines of Research in Smoke Abatement." Briefly, it may be said that it is only by a systematic investigation of the amount of deposit, its nature, and the diminution of light caused by the smoke cloud at different observing stations near our great cities, that the damage done can be evaluated and the origin of the smoke determined.

Though factories and works contribute greatly to the nuisance, the domestic chimney, so dear to the Briton, appears to be the offender most capable of correction, by the use of gas fires, coke fires, and semi-coked coal. Mr. Simon put forward the plea that the British Association should appoint a committee to co-ordinate the work of local municipal committees who are prosecuting research on the most efficient forms of domestic heating and the economical and smokeless use of fuel in general.

The position, so far as Manchester is concerned, was further explained by Mr. Haldane Gee and Prof. Knecht, the former reviewing the work carried out in Manchester during recent years, and the latter giving an account of Manchester smoke from the chemical point of view.

Prof. Wynne gave a number of statistics for the city of Sheffield based on an investigation of the rain-water collected in various soot gauges, from which it appears that if the district where the armament works are situated be excepted, the results for the other portions of the city show a remarkable approach to uniformity independent of the direction of the prevailing wind. If the contribution of house fires to the air pollution can be based on the proportion of tar and ammonia collected in the rain-water, no material difference could be traced between the winter and summer six months.

The effect of smoke on vegetation was considered by Prof. Ranwez and Mr. Ruston, the first describing the more general effects on trees and plants, while the second paid special attention to the reduction of sunlight, action of acids on leaves, soot formation, enzyme, and bacterial action. Smoke pollution is apparently an inhibitor of the enzymic chemical changes which occur in plants, and consequently near cities our plants are less bright, form less reserves, and produce seeds with diminished germinating capacity and energy, all which is but too apparent to the gardener in our urban districts. The electrical precipitation of smoke also came in for comment, and some slides shown by Mr. Vernon Harcourt incidentally illustrated well the possibility of combining economic fuel combustion on a domestic hearth with the artistic merits of the English fireplace, a point too infrequently considered, but most of the other speakers were concerned with the necessity for taking some action, compulsion if necessary, to force the inhabitants of this country to be more economical in fuel.

The outcome of the whole discussion, which in many ways was supplementary to that at the Birmingham meeting, was that a committee to consider the whole question of the economic use of fuel and smoke prevention was appointed by the Chemical Section.

The discussion on homogeneous catalysis was opened by Prof. Lewis, who advanced a new theory based fundamentally on Planck's quantum hypothesis. The physical idea underlying the theory is that ordinary or "thermal" reactions are due to the infra-red radiation which is necessarily present throughout any material system in virtue of its temperature. When a reaction proceeds without the addition of a catalyst, it is to be inferred that the density of the radiation "naturally" present in the system is sufficient to activate the molecules taking part in the reaction. Each type of molecule has its own characteristic absorption and emission bands in the infra-red, and can only be activated chemically by the absorption of radiant energy the frequency of which corresponds to one or more of these band positions. The function of a positive catalyst is to increase the radiation density of the frequency which corresponds to that of the reacting substance, a negative catalyst reduces the energy frequency of the "useful" frequency, and so hinders the rate of decomposition of the substance. By applying Planck's quantum theory to the simple case of a mono-molecular reaction Prof. Lewis deduced the following expression for the variation of the velocity constant (k) with the temperature (T):—

$$\frac{d \log k}{dT} = \frac{Nh\nu}{RT^2},$$

where N is the number of molecules in one gram-molecule, h is Planck's constant, R the gas constant per gram-molecule, and ν the characteristic infra-red vibration frequency of the reacting substance. By the aid of this expression values for ν can be calculated from temperature coefficient measurements. From measurements on the inversion of cane-sugar and hydrolysis of methyl acetate it was calculated that ν corresponded to a wave-length $1{\cdot}2\ \mu$ and $1{\cdot}9\ \mu$ values in fair agreement with the absorptions determined by Coblentz from transmission spectra. Prof. Lewis suggested that as aqueous hydrochloric acid possesses a band in the same region, its known positive catalytic effect is due to this cause, as also the catalytic effects due to pure and mixed solvents.

By considering that only those molecules react which reach a "critical" condition, namely, one in which they acquire a certain energy in excess of the average energy per molecule in the system, a view put forward by Marcelin in a series of papers on reaction velocity, Mr. J. Rice deduced a very similar expression for the relation of k to T to that given by Prof. Lewis. Considerable forces must hold the molecules together when near each other, but the law of force must be such that at a "critical" distance the attraction must weaken and change to repulsion, thus implying that the potential energy between two molecules is greatest at the critical distance apart. By assuming that the forces involved are electromagnetic and subject to modification due to the changes in radiation density produced by the catalyst, results are obtained in agreement with the existing experimental data.

Prof. F. Francis exhibited and described an apparatus for measuring the velocity of catalysis of nitrosotriacetonamine and allied derivatives by hydroxyl ions, based on the determination of the pressure of the nitrogen evolved. The method was also of use to determine the concentration of the hydroxyl ions. He also described the curious effect of neutral salts, and pointed out that nearly the same quantitative retarda-

tion of the velocity is produced in some cases by chlorides and hydroxyl ions. Small concentrations of sulphates produced an acceleration. Prof. Francis pointed out that the order in which the salts effected the velocity constant was that found in the lyotropic series, iodides producing the greatest and chlorides the least effect.

Dr. N. V. Sidgwick pointed out that while Prof. Lewis assumed the catalytic activity to be proportionate to the amount of catalyst, this was not always true, and further that temperature coefficients of isomeric changes and mono-molecular changes in general are abnormally high. The immediate need before proceeding to theory is an accumulation of more exact experimental data.

Prof. E. C. C. Baly from spectroscopic observations considered that as the first step in a chemical change must be the conversion of the reacting substance into an intermediate very reactive state, a positive catalyst must be an agent which converts more substance into this state. This intermediate state results from the introduction of a definite amount of energy. He suggested that probably the actual amount of energy thus needed was constant and independent of the value of the vibration frequency, and that the numbers of energy quanta necessary to produce the critical increment at any given vibration frequency of the molecule are numerically related to one another. Further, the relation between the active and inactive forms does not obey the law of mass action.

It may be fairly concluded from the discussion that far more experimental data must be accumulated, particularly as regards temperature coefficients and changes of velocity with increasing amount of catalyst.

Other parts of the mornings were occupied with several short papers, of which space will only permit the titles. Dr. H. F. Coward and Prof. A. Harden described and exhibited some lecture diagrams used by Dalton in illustration of his atomic theory; Dr. A. Hynd, "Configuration in the Sugar Group"; Dr. H. J. S. Sand, "A New Cadmium Vapour Arc Lamp"; Dr. Robert Mond, "Ruthenium Di-Carbonyl"; Dr. W. E. S. Turner, "Ionisation in Solvents of Low Dielectric Constant," and, jointly with Mr. J. D. Cauwood, "The Molecular State of Salts in Solution."

On one afternoon Prof. W. J. Pope gave an experimental lecture on liquid crystals, and on the other Prof. W. A. Bone, Prof. H. B. Dixon, and Dr. H. F. Coward contributed papers on combustion and explosion of gases with some experimental illustrations.

The account of the work of the section would not be complete without a word about the discussion on isotopes, which took place in Section A, but which was peculiarly interesting to chemists. The discussion is summarised in the report of the proceedings of Section A in NATURE, but results obtained by Dr. Whytlaw Gray from microchemical experiments showed that certain salts, iodides, chlorides, chromates, etc., of the product of decay of radium emanation are identical as far as solubility, crystalline form, etc., with the corresponding salts of lead. Approximate determinations of their melting points also indicated identity. To the chemist this is perhaps more convincing than a volume of deductions by a physicist.

GEOGRAPHY AT THE BRITISH ASSOCIATION.

THE president of the section, Major Lyons, was unable to be present, owing to pressure of work in connection with the war, and his address, the main part of which was printed in NATURE of September 23, was read by Mr. H. Yule Oldham. His other duties were undertaken by the vice-presidents, Mr. G. G. Chisholm, Prof. J. W. Gregory, Mr. Harry Nuttall, and Mr. H. Yule Oldham.

On Wednesday morning Mr. A. R. Hinks gave an account of the map which is being compiled at the Royal Geographical Society under the direction of the General Staff on the scale of 1 : 1,000,000. After a brief statement regarding the inception and progress of the map, and the principles upon which it is being compiled, he referred in more detail to various methods of showing relief, the selection of names, the index to boundaries, and marginal names. Mr. B. C. Wallis followed with a paper on methods of representing the distribution of population upon maps, and more especially upon the maps already described by Mr. Hinks. Taking the Buda-Pest sheet, he showed how the population in each administrative area might be assumed to be evenly distributed throughout, and how the density when located in the centre of the area might be treated in the same way as a spot height in contouring. He also showed maps, and discussed methods for the representation of the various ethnic elements in the population.

Wednesday afternoon was devoted to a series of short papers by members of the section who had been present at the Australian meeting. Mr. O. J. R. Howarth compared several well-known maps showing the distribution of vegetation in Australia, and pointed out the great discrepancies which existed between them. He suggested that a committee might at some suitable time be appointed to examine and criticise the material upon which distributional maps in general are based, and that such a committee might begin its labours by a consideration of the material available for the construction of vegetation maps of Australia.

Prof. J. W. Gregory discussed the relations of the central lakes of Westralia, which he believes to be basins left by the dismemberment of a Miocene river system. He considers that the drainage from lakes Giles, Barlee, and Ballard originally passed through Lake Raeside south-eastward to the sea, and that the channel from Lake Ballard south-west through Lake Deborah to the Swan River, indicated on a recent contour map of Western Australia, was of later date and was formed by the blocking of the south-eastern outlet by wind-borne drifts.

Mr. J. McFarlane described the Burrinjuck Dam and the Murrumbidgee irrigation area in New South Wales, with special reference to the interaction between man and his environment in an irrigation area.

Mr. H. Yule Oldham explained the various stages in the explorations by which the outline of the Australian continent had been filled up.

Thursday morning was devoted to joint discussions with Sections C and H respectively. The discussion with Section C on the classification of land forms was opened by Dr. J. D. Falconer, who proposed to set up two classes of land forms, each containing two orders :—

Class A, endogenetic forms: Order I., negative forms; Order II., positive forms. Class B, exogenetic forms: Order I., degradation forms; Order II., aggradation forms.

The two orders of endogenetic forms are then subdivided into four families :—

Family 1. Forms due to superficial volcanic activity.
2. Forms due to sub-crustal volcanic activity.
3. Forms due to radial movements.
4. Forms due to tangential movements.

Similarly, the two orders of exogenetic forms are each subdivided into nine families :—

Family 1. Forms due to the action of the run-off
2. Forms due to the action of percolating water.

3. Forms due to the action of streams and rivers.
4. Forms due to the action of life.
5. Forms due to the action of lightning.
6. Forms due to the action of sun-heat.
7. Forms due to the action of the atmosphere.
8. Forms due to the action of frozen water.
9. Forms due to the action of the sea.

Each family is then subdivided into genera and species or specific forms.

In the discussion which followed, Prof. Gregory said that the initial difficulty lay in the fact that different classifications were required by geography and by geology. Dr. Falconer had restricted the term land-form to what may be called the simple land forms, whereas the term was originally used for the greater features which may be called compound land forms. The geographer needs a classification which is based more on form than on origin, and uses familiar terms, such as mountain and valley, with the help of which he cannot afford to dispense. At the same time, Prof. Gregory thought that Dr. Falconer's classification would be of great value as a complete systematic tabulation of land-forming processes. Prof. Grenville Cole said that a systematic classification of land forms might tend to check the descriptive faculty of the teacher. Brief but comprehensive description in language familiar to the reader or hearer was needed to bring home the relation of surface features to man's life among them. Close definition, especially in the Greek language, might tend to obscure the beauty of a landscape. Mr. G. G. Chisholm considered that the distinctive feature of geography was the study of the influences of terrestrial local conditions and place relations. For this, of course, description was necessary, but he failed to see the utility for geographical description of the subdivisions of simple land forms proposed by Dr. Falconer.

The discussion with Section H on Racial Distribution in the Balkans was opened by Prof. G. Elliot-Smith. An account of it will appear under the proceedings of Section H.

In the afternoon a paper was read by Mr. P. M. Roxby on North China and Korea, in which he embodied many of the observations he had made in these regions during his tenure of an A.K. fellowship. He dealt principally with the railway situation, the relations of China to Russia and Japan, China's interest in the European war, and the work of the Japanese in Korea. The paper was illustrated by an exceptionally fine set of lantern-slides. Dr. R. N. Rudmose Brown followed with an account of the political and economic position of Spitsbergen at the outbreak of war. He also explained the results obtained by Dr. W. S. Bruce's expedition there in 1914.

On Friday, the first business before the section was the consideration of the report of the committee appointed to inquire into the choice and style of atlas, textual and wall maps for school and university use. Thereafter a paper was read by Mr. Raymond Curtis on the distribution of population in the district round Leek, in which he showed how in the agricultural area the village nucleus of farmhouses might develop in turn into the inn-village, the shop-village, the fair-village, and the market-town. Mr. C. B. Fawcett discussed the development of the middle Tees and its tributaries. He considered that the river system as a whole is in a comparatively early stage of development, but that it is the product of at least three distinct cycles of erosion. The morning sitting concluded with a paper by Prof. H. J. Fleure on the distribution and movement of population in South Britain in early times. In Neolithic times the chief areas occupied in England were the chalk downs, the moorlands of the south-west, the Cotswold top, a few patches, especially near Birmingham, in the Midlands, some valleys in the East Anglian Chalk, as well as a few chalk ridges, *e.g.* above the Fen edge, the Pennines, moorland tops in South Wales, etc. Descendants of the dark, long-headed Neolithic folk who occupied these uplands are still found in the valleys around them, except that they have been nearly washed out along the Chalk in the south, which has been the scene of many invasions. The valleyward movement of people in Britain is therefore of great importance, and evidence was given of its various stages and sociological results.

The proceedings of the section concluded on Friday afternoon, when Prof. Patrick Geddes read a paper on the study of cities, and at its conclusion conducted a party over an exhibition arranged by himself and Miss Barker of maps, pictures, books, and broadsheets illustrating the war, and of regional surveys illustrating the geographical and historical growth of cities.

JOHN MCFARLANE.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

LONDON.—A memorial service for members of the University who have fallen in the war was held at the Temple Church on November 1. The service was conducted by the Master of the Temple, assisted by Bishop Hine and the Bishop of London. The Bishop of Kingston was the preacher. Included in the list of the 250 graduates and students commemorated are the forty-two from University College, thirty from King's College, eighteen from the Royal College of Science and the Royal School of Mines, sixteen from the City and Guilds College, seventeen from the South Eastern Agricultural College, seventeen from St. Bartholomew's Hospital, fourteen from Guy's Hospital, nineteen from London Hospital, and eleven from St. Mary's Hospital.

It is understood that the appointment of a Principal to succeed Sir Henry Miers is to be postponed.

The first list of students serving in the war, to whom honorary war degrees have been granted, has been published.

OXFORD.—The Vice-Chancellor's choice of a Romanes lecturer has this year fallen on an Oxford resident, viz., Prof. E. B. Poulton, Hope professor of zoology. The subject chosen, "Science and the Great War," is one to which Prof. Poulton is known to have given great attention. For many years past he has lost no opportunity of advocating an increased attention to the results of scientific research in relation to all forms of national activity, whether warlike or peaceful, and he has consistently deplored the indifference to the lessons of science displayed by most of our leading politicians and statesmen. A valuable and interesting utterance on his part is confidently looked for. The lecture will be delivered at the University Museum, on Tuesday, December 7, at 3.30 p.m.

IT is stated in the *Pioneer Mail* of October 9 that on October 1 the Bill to establish and incorporate a teaching and residential Hindu university at Benares was passed into law. Now that the Bill has been passed, the promoters are about to address themselves to details connected with the institution. The Viceroy will lay the foundation-stone early in February. It is hoped that the work of the University will be entered upon by July next, though, of course, at first on a limited scale.

THE calendar for the present session of the University of Sheffield provides an excellent example of the numerous directions in which a modern university succeeds in meeting the needs of the area in which it is situated. The industries of the Sheffield district are reflected in the degrees in applied science which the University is prepared to confer. Students may take courses in preparation for the degrees of bachelor, master, or doctor in engineering science, or in metallurgy. In both these subjects, too, considerable specialisation is encouraged. The examinations of the University admit to associate membership of various professional institutions, and are also recognised by certain Departments of State. The University grants a diploma in domestic science. A two years' course of work in the University and the Sheffield Training College of Domestic Science has been arranged. The scientific portion of the course will be taken at the University, and the technical work in cookery, laundry, and housewifery at the training college. The calendar also provides full information of a well-planned University extension scheme which has been developed, and of numerous flourishing university societies. At the same time the more usual University work is carried on in the faculties of arts, pure science, medicine, and law, concerning which detailed particulars are given.

THE abridged calendar for the current session of University College, University of London, has been received. Detailed guidance is given as to the courses which should be taken by students proposing to graduate in one of the faculties of the University. The calendar points out that facilities for post-graduate work and research are provided in all departments of the college. There is a large science library in which the books concerned with the various scientific departments are grouped. The library contains all the most important scientific periodicals (British and foreign). The particulars of the studentships, scholarships, fellowships, and prizes for research awarded by the college run to forty-eight pages. The list of original papers and other publications from the various departments of the college since the provost's report in last year's calendar fills fourteen pages, and is good evidence that the reputation of the college as a centre for research is being worthily maintained. In his report, printed in the calendar, on the work of the last session at the college, the provost said the benefactions of the year had inevitably been fewer than usual, but he was able to announce that upwards of 1100*l.* had been added to the fund for the new chemical laboratories. He said a further sum of between 800*l.* and 900*l.* was needed for the partial minimum equipment for this session. The equipment necessary for the new physico-chemical laboratory is of a special and expensive character, and will cost about 10,000*l.*

THE calendar for the present session of the University College of North Wales has been received. Students of the college prepare for degrees of the University of Wales, which have been so framed as to allow great freedom in the choice of subjects of study. Each degree in arts or science may be regarded as a certificate of the preliminary knowledge required at matriculation, and of subsequent study pursued at one of the constituent university colleges for a period of three years, and tested at each stage by university examinations. Advanced study is encouraged not only by the existence of advanced and honours courses, but also by the regulations for the higher degrees, and by the award of university fellowships and studentships for research. As an instance of the encouragement given to research we notice the calendar states the professor of mathematics is glad to furnish subjects for research in applied mathematics to candidates who have acquired a substantial knowledge of the subject-matter of the honours course and to direct their work. A number of aeroplane problems are generally available. In the agricultural department of the college, students may prepare for degrees in agriculture and rural economy or for the college diploma in agriculture, and their practical work is assisted by the facilities provided at the college farm of 675 acres. With the aid of a grant from the Development Fund, well-equipped laboratories have been provided, and full facilities are now available for the investigation of problems submitted to the department.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, October 26.—M. Ed. Perrier in the chair.—G. **Bigourdan**: Astronomical observations made in France before the foundation of the Academy of Sciences. An outline of the life of Fabri de Peiresc (1580–1637).—H. Le **Chatelier** and B. **Bogitch**: The preparation of alkaline nitrates starting with calcium nitrate. The preparation of ammonium nitrate by the interaction of calcium nitrate and ammonium sulphate presents difficulties on the large scale owing to the pasty mass being nearly impossible to filter. After heating under pressure in a closed vessel to 150° C., the calcium sulphate forms larger crystals, and the ammonium nitrate can be readily removed by washing.—Fréd. **Wallerant**: Some crystallographic peculiarities of aniline nitrate. This salt is dimorphous, with a well-marked transition point at 97·6° C.—Henryk **Arctowski**: Variations in the ratios between faculæ and sun-spots.—Luc **Picart**: A criterion for the identification of the minor planets.—Ernest **Esclangon**: The quasi-periodic integrals of a linear differential equation.—A. **Angelesco**: Associated polynomials with several variables.—St. **Procopiu**: Electromotive force due to motion. A study of the electromotive forces set up in a symmetrical cell (metal-electrolyte-metal) by motion of one electrode or of the electrolyte.—A. **Guilliermond**: Some cytological observations on the mode of formation of anthocyanic pigments in flowers.—G. **Rivière** and G. **Bailhache**: *Amygdalopersica formonti.* An account of some peculiarities in the growth of an almond grafted on to a peach tree.—Th. **Guilloz** and E. **Stock**: A compass for the location of metallic fragments in the body.—E. **Vasticar**: The structure of the auditory cell.—F. **d'Hérelle**: The biological method for the destruction of locusts. Details of an improved method for utilising the *Coccobacillus acridiorum* for the destruc- of locusts.—E. **Aubel** and H. **Colin**: The reaction of the medium and filtration of toxins.

BOOKS RECEIVED.

The R.P.A. Annual for 1916. Pp. 80. (London: Watts and Co.) 6*d.* net.

Illustrations of Positivism. By Dr. J. H. Bridges. New edition, enlarged and classified by H. G. Jones. Pp. xiii+480. (London: Watts and Co.) 3*s.* 6*d.* net.

The Dramas and Dramatic Dances of Non-European Races in special reference to the Origin of Greek Tragedy. By Prof. W. Ridgeway. Pp. xv+448. (Cambridge: At the University Press.) 15*s.* net.

Field Analysis of Minerals. By G. D. McGrigor. Pp. 86. (London: *The Mining Magazine.*) 3*s.* 6*d.* net.

Food Economy in War Time. By Profs. T. B. Wood and F. G. Hopkins. Pp. 35. (Cambridge: At the University Press.) 6d. net.

Forty-fourth Annual Report of the Local Government Board, 1914–15: Supplement in Continuation of the Report of the Medical Officer of the Board for 1914–15, containing a Report on Maternal Mortality in connection with Child-bearing and its relation to Infant Mortality. Pp. 140. (London: H.M.S.O.; Wyman and Sons, Ltd.) 7½d.

Modern Chemistry and its Wonders. By Dr. G. Martin. Pp. xvi+351. (London: Sampson Low and Co., Ltd.) 7s. 6d. net.

The Student's Handbook to the University and Colleges of Cambridge. Fourteenth edition, revised to June 30, 1915. Pp. 14+701. (Cambridge: At the University Press.) 3s. net.

The Caliph's Last Heritage: a Short History of the Turkish Empire. By Lt.-Col. Sir M. Sykes. Pp. xii+638. (London: Macmillan and Co., Ltd.) 20s. net.

Statistical Theory of Energy and Matter. By Dr. T. Wereide. Pp. xv+170. (Kristiania: Gyldendalske Boghandel Nordisk Forlag.)

Tasmania. Department of Mines. Geological Survey Bulletin, No. 20: The Catamaran and Strathblane Coal Fields and Coal and Limestone at Ida Bay (Southern Tasmania). By W. H. Twelvetrees. Pp. 59; Maps and Sections. (Hobart: J. Vail.)

Canada. Department of Mines. Mines Branch: Results of the Investigation of Six Lignite Samples obtained from the Province of Alberta. By B. F. Haanel and J. Blizard. Pp. viii+110. Report on the Salt Deposits of Canada and the Salt Industry. By L. H. Cole. Pp. vii+152. (Ottawa: Government Printing Bureau.)

British Birds. Written and illustrated by A. Thorburn. In four volumes. Vol. II. Pp. vi+72+plates 21–40. (London: Longmans and Co.) Set of 4 vols., 6 guineas net.

An Introduction to Social Psychology. By W. McDougall. Ninth edition. Pp. xvii+431. (London: Methuen and Co., Ltd.) 5s. net.

Mechanical Technology: being a Treatise on the Materials and Preparatory Processes of the Mechanical Industries. By Prof. G. F. Channock. Pp. x+635. (London: Constable and Co., Ltd.) 7s. 6d. net.

Unit Photography. By F. M. Steadman. Pp. xi+160. (London: Constable and Co., Ltd.) 8s. 6d. net.

Limes and Cements: Their Nature, Manufacture, and Use. By E. A. Doncaster. Pp. xii+212. (London: Crosby Lockwood and Son.) 5s. net.

The Molecular Volumes of Liquid Chemical Compounds from the Point of View of Kopp. By G. Le Bas. Pp. xii+275. (London: Longmans and Co.) 7s. 6d. net.

The Life Story of an Otter. By J. C. Tregarthen. New edition. Pp. xiii+188. (London: J. Murray.) 2s. 6d. net.

The Story of a Hare. By J. C. Tregarthen. New edition. Pp. xi+196. (London: J. Murray.) 2s. 6d. net.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 4.

ROYAL SOCIETY, at 4.30.—A Diagram to Facilitate the Study of External Ballistics: Prof. W. E. Dalby.—An Application of the Principle of Dynamical Similitude to Molecular Physics: W. B. Hardy.—The Motion of a Stream of Finite Depth past a Body: R. Jones.—Deep-sea Water Waves caused by a Local Disturbance on or beneath the Surface: K. Terazawa.—The Consumption of Carbon in the Electric Arc: W. G. Duffield.

SOCIETY OF ENGINEERS, at 7.30.

TUESDAY, NOVEMBER 9.

MINERALOGICAL SOCIETY (Anniversary Meeting), at 5.30.—Crystallographic Relations of Allied Substances traced by means of the Law of Valency Volume: W. Barlow.—Torbernite: A. F. Hallimond.—The Solution of the Problem of Four Tautozonal Poles: T. V. Barker.—Crystals of Iron Phosphide from a Blast-Furnace: L. J. Spencer.—The Meteoric Stone of Cronstad, Orange River Colony: Dr. G. T. Prior.

ZOOLOGICAL SOCIETY, at 5.30.—Some Notes upon the Anatomy of *Rana tigrina*: Dr. G. E. Nicholls.—(1) The Distribution of Secondary Sexual Characters amongst Birds, with Relation to their Liability to the Attack of Enemies; (2) Some Observations on Pattern-blending, with Reference to Obliterative Shading and Concealment of Outline: J. C. Mottram.—A Collection of Mammals from the Coast and Islands of S.E. Siam, with an Account of the Fruit-bats by Dr. Knud Andersen: C. Boden Kloss.—Fauna of West Australia. III. A New Nemertean—*Geonemertes dendyi*, sp. n.—being the First Recorded Land Nemertean from Western Australia. IV. *Palæmonetes australis*, sp. n., being the First Record of the Genus in Australia: Prof. W. J. Dakin.

THURSDAY, NOVEMBER 11.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* Effects of Function Activity in Striated Muscle and the Submaxillary Gland: J. Barcroft and T. Kato.—Studies on *a priori* Pathometry. I.: Sir Ronald Ross.—The Spread of the Excitatory Process in the Vertebrate Heart. I. The Toad's Ventricle. II. The Tortoise Ventricle. III. The Dog's Ventricle. V. The Bird's Heart. IV. The Human Ventricle: T. Lewis.—Analyses of Agricultural Yield. II. The Sowing-date Experiment with Egyptian Cotton, 1913: W. L. Balls and F. S. Holton.—Williamsoniella, a New Type of Bennettitalean Flower: H. H. Thomas.

FRIDAY, NOVEMBER 12.

ROYAL ASTRONOMICAL SOCIETY, at 5.

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THURSDAY, NOVEMBER 11, 1915.

CO-OPERATION IN SCIENTIFIC RESEARCH.

THE principal part of all scientific discovery and research in past time has been the result of private or individual work. Men of great originality and genius have struck out new lines of thought, or made epoch-making discoveries in moments of inspiration. Men of lesser originality, but painstaking workers, have contributed to knowledge by careful measurements or patient observations. In many cases useful partnerships of two or three have been established, in which the members have shared the labour and each contributed something the other lacked. In the early days of research, when the means of investigation in laboratories or apparatus were limited, only those who possessed in a high degree the capacity for discovery found or made opportunity to carry on such work and secure publication for it. At the present time, when laboratory accommodation is extensive and the numbers of the workers greatly multiplied, the difficulty is rather to find new subjects for research than the means wherewith to do it.

The result of this is seen in an enormous increase in the amount of published scientific memoirs, and in the disconnected nature of much of it. The Proceedings of our learned societies, from the Royal Society downwards, and of the technical institutions as well, are a record of an ever-increasing number of papers on subjects, for the time being, attracting attention, but which are quite detached in their manner of dealing with it. Take, for example, such topics as radio-activity, electric waves or oscillations, ionisation of gases, wireless telegraphy, radiation, and many other popular fields of research, and consider the enormous number of papers describing experiments on these subjects which have been published during the last twenty years. We have here the product of much arduous labour on the part of an army of scientific workers. Certain discoveries and papers stand out as landmarks and epoch-making. On the other hand, it is impossible to avoid asking the question whether much of the work of those who may perhaps be described as the privates and officers of lower rank in the scientific army could not have been made to yield more valuable results if it had been better co-ordinated and directed.

In no class of work involving many workers can we dispense with organisation. An army is not a collection of armed individuals. It is a machine in which each man is an element, with place and duty. An effective and successful commercial institution, such as a railway company, is a complicated organism, and not a multitude of persons, each playing for his own hand. The present method of conducting scientific research is a go-as-you-please method, in which each man does what his own inclinations suggest to him or the means at disposal allow him to do. It is perfectly certain that, as the result of this war, the British Empire will have forced upon it in all departments of activity, first, greater economy in the use of materials; secondly, greater efficiency in the workers; and, thirdly, greater demand for value in the result. We have to get rid, in every department of work, whether politics, commerce, manufacture, or domestic life, of waste, inefficiency, and make-believe or valueless products. We have to get rid of them in scientific research as well.

This can only be done by limiting the individual initiative and adopting greater and more carefully thought-out co-operation. It is well, therefore, to begin to consider the lines on which these reforms shall proceed. In the first place, they must begin at the fountain head. We must ask for greater effectiveness and more valuable results from the learned societies, because these represent the tendencies and ideals of the leaders of science. The Royal Society was originally founded to stimulate and encourage scientific investigation into natural phenomena, and its analogue in the technical realm, the Institution of Civil Engineers, to promote the utilisation of the forces and energies of nature for the use and benefit of mankind. Whilst these great objects are undoubtedly assisted by the facilities offered by these societies for the publication of accounts of new knowledge or new achievements, one great purpose which perhaps they might much more adequately fulfil should be to point out and direct the forces and energies of research in new and useful channels.

There is one way in which this might be done, and that is by carefully organised discussions on definite large problems and questions lying at the boundaries of our knowledge. The usefulness of the British Association meetings has been greatly increased of late years by such general discussions, as a result of much criticism by Sir William Tilden, Prof. H. E. Armstrong, Sir Oliver Lodge, and others.

Why, then, should not the Royal Society devote several meetings during the session to general

discussions, with careful prearrangement, having for their special object to elucidate the present state of knowledge on some particular subject, to define its unsolved problems, and suggest or indicate the most fruitful lines for future research and discovery? To such discussions eminent workers in the subject, even though not fellows, should be invited. The object should be to direct individual workers to lines of investigation converging in certain useful directions.

The example would then doubtless be followed by other societies; indeed, the Faraday Society has held several successful meetings of this kind. The function of such meetings should be to stimulate the thoughts and originality of the adult investigators, just as the teaching of a good teacher does for his students. Then, in the next place, valuable work might be done by the formation in these societies of committees of investigation, composed of small groups of members or fellows charged with the special duty of following out some particular line of experimental or theoretical work, and publishing the result as the joint work of the committee, and not of individual members of it. Such committees have often been formed and done much valuable work, and it suffices to mention the British Association Committee on Electrical Units to recall one of the most famous of them, and the Engineering Standards Committees of the Institution of Civil Engineers.

At the present time, members of learned societies either sit and listen to abstracts of papers read by others or read one of their own, but they seldom, if ever, find the opportunity of joining hands in a piece of joint work to which all would contribute an effective share. There are many fields of investigation in which the work of the mathematician, the physicist, the chemist, and perhaps the engineer could be united with great advantage, and far more valuable work done if each member of the partnership were to play for the team than simply for his own hand.

The mathematician is apt to direct his attention too much to problems in which the technique of his science is involved, and too little to the function of co-operating with experimental research in bringing us to fresh discovery. In like manner, the experimentalist may have his skill more rewarded if directed by the guidance of the mathematician, who can point out to him the best direction in which it can be utilised.

No doubt such co-operative work requires an amount of self-suppression which is not widely distributed, but it is what every public-school boy exhibits who plays cricket or football for his house and not for himself, or every soldier or sailor who puts "The Service" before everything concerning his own life and interests. Then the same thing applies to commercial research. Every British manufacturer who affords himself some small degree of scientific research in his business is anxious, before all things, to keep his difficulties and knowledge to himself. If he could be induced to see that his real foes are, not his own kindred, but the highly organised German manufacturers, perhaps he might be inclined to listen to suggestions for co-operative research maintained by common effort in the common interest. There are in all manufactures scientific problems which all concerned are interested in solving. These could probably be better dealt with by a strong and highly competent scientific staff maintained in common than by insufficient individual effort.

In this matter, however, we work in a vicious circle. Until the manufacturers recognise that sufficient inducement must be offered to the highest scientific ability to enter commercial service, the best men will not take up the work, and until such highly trained men with initiative are proved to be available, the manufacturers are sceptical as to the advantages of scientific assistance. Nevertheless, the supply will create the demand, and it is the duty of the universities and technical colleges to see that the training they provide turns out first-class, and not only second-class, men.

The Advisory Council concerned with the Organisation and Development of Scientific and Industrial Research should have all these matters in review. We stand at the entrance to a new era in the life of the world, and it is imperative that we should all look the facts fairly in the face, and realise that we have to attain in every department of national life a higher efficiency and more effective service for the common good.

SCIENCE AND ART OF ILLUSTRATION.

The Essentials of Illustration: a Practical Guide to the Reproduction of Drawings and Photographs for the Use of Scientists and Others. By T. G. Hill. Pp. xii+91. (London: W. Wesley and Son, 1915.) Price 10s. net.

If too little importance has been hitherto attached by the writers of scientific books to the way in which they have been illustrated, it is due to various causes, not the least of which is the want of guidance as to the manner in which pictorial illustrations are produced. Want of skill

in draughtsmanship, and want of artistic perception in the selection or arrangement of subjects, no doubt account for some of the shortcomings of illustrated scientific works. But beyond these causes there exists a third, unfamiliarity with the technical processes employed in the manufacture and printing of illustrations of different kinds. Drawings made with the pencil, the pen, or the brush require each of them a different treatment from that which is appropriate for photographs. The arts of copper-plate etching, of dry-point etching, of mezzotint, of wood-engraving, steel-engraving, lithography, and aquatint are each marked out for special preferences in particular cases. In the case of photographic reproduction the processes of photogravure, collotype, half-tone block making and line block making have each their own particular advantages; some are better for one subject, or for one kind of book, and others for other subjects or books. And this quite apart from any of the more complicated questions of reproduction in colour.

The volume before us is a brave and not unsuccessful attempt to guide the scientific writer, and to put into his hands a manual which in clear and simple language reviews the various means by which book illustrations are made, whether by hand or by camera, and converted into printed pictures. The author, who is a professed botanist and an accomplished artist to boot, possesses a wide acquaintance with the art of book illustration, and his references to leading works in which the pictures are produced in different ways are copious and appropriate. He is as much at home with the delightful wood-cuts of the old herbals of Fuchsius and Matthiolus as with the hand-coloured copper-plate engravings of Sowerby or the plates in the *Philosophical Transactions*. But for scientific workers other than botanists it will be tantalising to find that for examples of different kinds of illustration a majority of the references are to the volumes of botanical serials or to inaccessible and obscure botanical monographs. The abundance of excellent illustrations, nearly all original, including twelve plates and thirty-eight text-figures, goes far to atone for this defect.

Our author discusses his subject under the three headings of intaglio printing, plane surface printing, and relief printing. He deals with the first section in eleven pages, in which brief compass he includes technical descriptions of the processes of line engraving, etching, soft-ground etching, mezzotint, and photogravure. The instructions are too brief to be taken as working guides for the practice of the respective arts, but may serve to enable intelligent readers to recognise the process by which any particular illustration has been produced. Under the title of "Plane Surface Printing," a large amount of space is rightly devoted to lithography, though for the successful employment of this process a degree of craftsmanship is necessary to which few scientific book-writers can ever attain. Chromolithography is dismissed very briefly, as are photolithographic processes also; while more attention is given to collotype, a process which except in the hands of professional craftsmen is seldom satisfactory. Under the heading of "Relief Printing" are grouped the topics of wood-cutting and wood-engraving (of which arts the author wisely omits all technical instructions), the half-tone photo-mechanical process, the half-tone three-colour process, the production of photomechanical line-blocks, and the swelled-gelatine process. The survey is not quite comprehensive; it does not include the useful, if little used, process called "monotype" or "electrotint," which is one of the easiest for amateurs. It does not mention the excellent tungstate of lead process for line-blocks used by Messrs. Walker and Boutall. Neither does the author refer to the use of a process, common in the production of postage-stamps, of surface-printing transferred from an original that was engraved on copper or steel.

Probably the most useful parts of the work will be the passages intercalated between the descriptive matter, in which the author gives admirable advice to the writers of scientific papers on the preparation of their illustrations, on methods of drawing for reproduction, whether of line-diagrams, or of microscopic details, of maps, or of graphs. He advises, on the whole, against the use of separate plates, and is in favour of illustrations incorporated in the text, and therefore printed from relief-blocks. Some of the suggestions about spacing out figures on a plate or avoiding the abomination of glazed paper, are, if rather naïve, decidedly apposite. By way of affording comparison between results of rival methods three plates are given, produced from the same photographic negative (a salt-marsh in Brittany) in photogravure, in collotype, and by half-tone block respectively. All are excellent; but the half-tone block is remarkably good.

The recommendations as to drawing for the purpose of reproduction are excellent, but the author should not call the art of "lettering" (so neglected by non-professional draughtsmen) by the name of "printing"; that is exactly what it is not. Very useful hints are given as to the aid to be derived by drawing in waterproof ink upon an ordinary photographic silver-print, which is then bleached out chemically (recipes given for the bleaching agent), leaving a useful line-drawing.

Very useful, too, are the remarks as to the stages, in the various processes, at which corrections may be made. We miss certain references which might be expected. There is no mention of the etched copper-plates of Hooke's "Micrographia" (1665), with its celebrated enlargement of *Pulex irritans*; or of the use of copper-plate etchings printed in the text as in many early books in science; or any reference to the great advantage (if properly printed) of wood-engraved line diagrams with lines and letterings cut in white against a black background, as in the "Œuvres de Verdet," admirably printed about 1870 at the Imprimerie Nationale of France. But the success of these last-named cuts depends essentially upon the quality of the ink used, a weak point with almost every English printing house, as William Morris discovered when he wished to produce the Kelmscott books. For some unknown reason English printers prefer a "grey" to a really fine black printing; and the ink they habitually use would be quite unsuitable for some of the finely-cut blocks which adorn certain recent German text-books of physics. The final chapter on relative cost of blocks and plates is, in spite of some defective arithmetic, commendable.

On page 67 the author makes the comment that drawings of microscopic details, usually produced by lithography, ought not to be so, "since the figures are necessarily divorced from the letter-press." This is an entire blunder. One of the most satisfactory of modern text-books, the "Practical Pathology" of Prof. G. Sims Woodhead, has more than a hundred exquisite illustrations, in two or three colours, printed in the text. The printing of this and other kindred books seems to be an enviable speciality of a firm of Edinburgh printers.

A final word of praise must be given to the manner in which this book is itself produced. The typography is far above the average; and in respect of clear type, wide margins, and clean imposition is a credit to the press from which it issues. The omission of an index is an unpardonable sin, for which the printer is not responsible.

S. P. T.

ABORIGINAL INHABITANTS OF NEWFOUNDLAND.

The Beothucks or Red Indians, the Aboriginal Inhabitants of Newfoundland. By J. P. Howley. Pp. xx+348. (Cambridge: At the University Press, 1915.) *1l. 1s.* net.

THE Beothucks described in this fine monograph, the result of the life-long devotion of Mr. Howley to the investigation of this mysterious tribe, are an ethnological puzzle, and, like that of the Tasmanians, with the scanty material at our disposal it is practically insoluble. In the case of these two races we possess little material save some articles recovered from their graves or camps and the more or less vague and fragmentary accounts of untrained observers.

The Beothucks were relentlessly attacked on two sides: by the Micmacs, an intrusive Algonkin race from the American mainland, and by the French and British hunters and fishers who began to visit Newfoundland when its valuable fisheries became known in Europe.

As in the case of the Tasmanians, the last survivor was a woman, who died in 1829. Before their final disappearance the conscience of the colonists had been aroused to the tragedy of the destruction of a friendless and generally inoffensive people. An institution for their protection was established, and expeditions were sent in search of the survivors, but without much result. One exploring party came into touch with them in 1810, but owing to misunderstandings and some lack of intelligence on the part of the leaders, little was learned about them. We know that they lived in circular or octagonal huts with a fireplace in the centre, round which in a circle of pits the occupants sheltered themselves from the rigours of winter. They were a tall, robust people, dressed in skins, armed with bows and arrows, spears, and clubs. They did not, like the Indian tribes of the mainland, scalp their dead enemies; they cut off their heads and stuck them on poles. Of their religious beliefs we know little. They recognised a life after death, and that the spirit held some sort of communication with the survivors, and they seem to have believed in some greater spirit, like the Manitou of the Indian tribes. They are said to have washed themselves only after the death of their wives, a rite pointing to some kind of belief that the ghost clung to its nearest relative. They used red ochre freely as an ornament.

It is difficult to decide their racial affinities. Some believe them to be connected with the Red Paint people of Maine. A wilder theory represents them as the descendants of Scandinavian ancestors, but this is disposed of by their skull measurements and the scanty vocabularies which survive. They were probably not allied to their nearest neighbours, the Micmacs and the Eskimo, but they may have been a branch of the Algonkins, modified in appearance and manners in their new environment. This migration from the mainland must have been early; otherwise their language would more closely resemble that of the continental tribes.

It is easy to blame the early colonists for the

destruction of this tribe, but for this a heavier responsibility rests on the Micmacs. Mr. Howley's book tells all that can now be discovered about them. Even if it shows lack of literary skill and in some places might have been with advantage abridged, it is an adequate record of a regrettable chapter in the history of the colony. In its format and illustrations it is worthy of the traditions of the Cambridge University Press.

THE RESISTANCE OF SHIPS.

Ship Form, Resistance, and Screw Propulsion. By G. S. Baker. Pp. vii+247. (London: Constable and Co., 1915.) Price 12*s*. 6*d*. net.

THE author of this book is the superintendent of the William Froude experimental tank at the National Physical Laboratory, and it is with the results of model experiments in this and other such tanks that the greater part of the book is concerned. While there is little new material in the book, it forms a valuable collection of collated data in ship form and resistance research, and from this point of view should be useful to the student of naval architecture and to the designer to whom the services of an experimental tank are available. Full reference has been made throughout to the work of Taylor, Biles, Froude, and Peabody. Such research results as the author considers to be of permanent value have been collected and analysed, and although opinions will differ as to the value of much of the great mass of matter which has been ignored, the book shows evidence of much care in sorting and examining published data.

The book is divided into two sections, the first dealing with "Ship Form and Resistance," and the second with "Screw Propulsion." In the first and most successful part of the book, the theory of ship resistance, with its dependence on skin friction and on eddy and wave-making resistances, is first considered. The effect of form and of variations of form on these separate sources of resistance is considered in detail, and much attention has been paid to the analysis of experimental data bearing on this part of the work. Particular emphasis is laid on the importance of the "prismatic" or "longitudinal" coefficient of a vessel, as opposed to its "block" coefficient. Experiment clearly shows that the resistance of a ship, and more particularly the form of its resistance-speed curve, depends chiefly on the longitudinal distribution of its displacement. A large part of this first section of the book is devoted to the effects on resistance of varying lengths of entrance, run, and parallel middle body, work with which the author's own investigations have been largely concerned.

There is a useful chapter on the form and resistance of high-speed vessels of abnormal type, including hydroplanes and the floats of seaplanes, and a further chapter deals with the effect on resistance of varying depths of water and of restriction in the waterway of narrow channels.

The second portion of the book deals briefly with the various theories of the screw propeller; with the elements of screw propulsion; and the design of propeller blades. Screw efficiency, with the allied questions of hull efficiency, wake deduction, and thrust deduction, are clearly explained in a very satisfactory series of chapters. A chapter is devoted to a consideration of the phenomenon of cavitation, and one to a brief sketch of the main engine. This forms the least satisfactory portion of the book. In the chapter on cavitation there is much loose definition and lack of precision, which will probably be rectified in any further edition, while the chapter on the main engine is very superficial. The book would not suffer appreciably by the deletion of this section. The final chapter touches briefly on the tabulation, plotting, and analysis of measured-mile trials.

The book as a whole is well arranged and has a good index.

OUR BOOKSHELF.

Elementary Lessons in Electricity and Magnetism. By Prof. S. P. Thompson. New Edition. Pp. xvi+744. (London: Macmillan and Co., Ltd., 1915.) Price 4*s*. 6*d*.

THIS well-known book has become almost a classic for those beginning the study of electricity and magnetism. It is an encyclopædia of information on all things electrical. A new edition of a volume that attempts so much, in a science which develops so rapidly as electricity, must suffer many changes, and the new volume contains two interesting new chapters—one on wireless telegraphy, and the other on the modern conception of the electron. It is a tribute to Prof. Thompson's skill as an expositor that he deals in a short chapter with such difficult problems as those involved in the consideration of the oscillations in the coupled circuits of a high frequency oscillation transformer. The chapter on electrons is also a welcome addition. The author has managed to compress into a dozen pages as much information on this subject as is usually contained in books of much larger size.

It is a matter for regret that Prof. Thompson has not stated Ohm's law as it is generally understood at the present time. Ohm's law as stated by Ohm, without the condition of unaltered physical properties, is not a law at all. In the text it is stated that the "resistance of a given

conductor is, in fact, constant, *so long as its physical properties are unaltered*," and this is the only meaning Ohm's law can have if it is a law and not a statement without physical significance. But this is a small point to criticise where so much is excellent.

It is as a historian and recorder that Prof. Thompson has earned the gratitude of electrical engineers and physicists as much as in any other direction; and from that aspect alone his "Elementary Lessons in Electricity and Magnetism" is worth reading.

Market Gardening. By Prof. F. L. Yeaw. Pp. vi + 102. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1915.) Price 3*s*. 6*d*. net.

THIS little book is intended to serve not only as an elementary text-book of market gardening, but as an introduction to vegetable-growing in school and home gardens as well.

To attempt to deal with so complex a subject within the space of 68 pages of bold type was heroic, and only an author well acquainted with his subject could have given so much trustworthy information in so small a space. We could wish that its admirable points had been still further elaborated for the use of beginners, who are assumed to know more of manual processes than is likely to be the case.

Viewing it as an account of American market gardening, one is struck with the remarkable omissions concerning things which we believe, on this side of the Atlantic, to be of the first importance. Intercropping is illustrated by four excellent plates, but only once incidentally mentioned in the text; rotational and successional cropping are not mentioned at all. No help is given as to the selection of profitable varieties. The spade apparently finds no place even in the home garden, and many labour-saving devices, methods, and appliances well known here seem to be unknown there. Sub-irrigation is not mentioned, and only twenty-three crops are dealt with, whereas our market gardens accommodate nearly double that number (not including fruits and flowers). More notes upon the cost of raising crops, the returns to be expected, and the like, would have been valuable; only here and there is this mentioned.

F. J. C.

The Student's Handbook to the University and Colleges of Cambridge. Fourteenth edition. Revised to 30 June, 1915. Pp. 701. (Cambridge: At the University Press, 1915.) Price 3*s*. net.

THOUGH the statements made in the handbook are not official, every care has been taken by reference to competent authorities to make them accurate. The temporary emergency legislation occasioned by the war is recorded in this new edition. This legislation refers, among other matters, to the allowance of terms and examinations to students on active service, and the modification in their case of various fees; and also to the modification of certain examination regulations.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Origin of New Adaptive Characters.

THE author of the article in NATURE of July 15 entitled "The Material Basis of Evolution" has misunderstood some of the chief bearings of my address entitled "Origin of Single Characters as Observed in Fossil and Living Animals,"[1] and I would regret to have certain passages in this well-intentioned review quoted as expressing my opinions. My address was based on researches carried on continuously since 1889 on the actual modes of origin of single specific and generic characters as observed in several lines of mammalian descent (horses, rhinoceroses, and titanotheres) in which such characters can be traced from their beginnings to their final development without any break. The term *numerical* was used as a convenient designation for all characters which may be expressed in numbers and formulæ, while the term *proportional* was used for such characters as may be expressed in indices and ratios.[2] There is a clear genetic distinction between these two kinds of characters, for while changes of proportion, such as the reduction of the lateral digits of the feet of horses, gradually lead into changes which may be expressed numerically, such reduction-changes fall under laws which govern quantitative changes in general rather than laws which govern the origin of new characters.

It is in the origins of new adaptive organs, such as the horn rudiments of the skull of mammals, that we observe another evolutionary principle in operation, whereby descendants of the same ancestors give rise to *similar* numerical characters, both in near and remote lines of descent, while at the same time they may give rise to entirely *dissimilar* proportional characters. In other words, there is some principle of ancestral hereditary predisposition or control in the origin of many new numerical characters which we cannot at present understand or explain. Nor can we now explain the causes of the origin of proportional characters, because both the Lamarckian and the Darwinian explanations fail in certain cases. The principle of ancestral predisposition also operates in the proportional evolution of nearly related lines of descent, although not in the remote lines.

The distinction between numerical and proportional is further sustained by the fact that modern mammalogists, such as Miller and Osgood, in their systematic treatises on carnivores and rodents, employ either proportional or numerical characters in all their definitions; in practically all systematic treatises on the hard part of mammals this distinction is used in definition. Proportional characters are far more common than numerical. The observations of Osgood, moreover, which are on an unprecedented scale, embracing the examination of more than 27,000 specimens of Peromyscus, are in absolute accord with my results obtained in palæontology, namely, that there is a complete continuity (rather than discontinuity or saltation) in the origin of proportional characters and in the origin of several, if not all, of the numerical characters observed.

As to the De Vries mutation hypothesis, it is ex-

[1] Presidential address before the Palæontological Society of America delivered in the Academy of Natural Sciences of Philadelphia, December 31 1914.

[2] Technically these terms are replaced by the designations "rectigradations" and "allometrons."

pressly not stated in my address, as quoted by my reviewer, "that there is no evidence whatever in support of the theory that 'species' may arise from fortuitous, saltatory characters." No such sweeping statement is made; on the contrary, the much more guarded statement is made (p. 229) that, "I do not know of a single instance where a field observer in mammalogy or in palæontology has recorded a new saltation [*i.e.* mutation] character which is known to be of any significance in the evolution of the race. . . . Saltation is, however, theoretically probable in certain numerical and meristic characters, such as supernumerary teeth and vertebræ."

Nor has the reviewer understood my observations regarding the nature of species and genera. The Darwinian tradition as to the actual modes of evolution of species, which is closely followed by De Vries and Bateson to-day, may be described as a "single character" or "group character" doctrine, namely, that the evolution of species manifests itself suddenly in one character or group of characters; that whenever such character or characters arise through individual variation or through saltation, they may be fixed in the race by selection. This was one of the essential features of our former conception of evolution, namely, that an organism advances now here, now there; it was drawn from ancient traditions about the nature of "species" entirely prior to the period of palæontological discovery of the actual modes of evolution of animal forms. These date back to the discovery of mutation by the German palæontologist Waagen in 1869, mutation in an entirely different sense from that of De Vries. Palæontology has now demonstrated that we must abandon this "single character" conception of evolution, because it proves that every organism is made up of an almost infinite number of characters, each of which is in a continuous state of movement, either originative, progressive, or retrogressive. This is a law well observed and established through palæontology, for which at present we offer no theoretical explanation whatever. The "single characters" and "group characters" of the older systematists and of Darwin are now seen to be those which, although part of a large general advance or retrogression, happen to be so conspicuous as to attract the eye of the zoologist. In my address this newly-discovered law of multiple-character evolution is shown to be entirely in accord with the theory of the "unit-character" constitution of the germ, which chiefly dates from Mendel's discoveries.

In regard to natural selection, I am not convinced, as my reviewer states, "that all characters must run the gauntlet of selection." On the other hand, I give it as my theoretic opinion (p. 239) that "Selection is operating always upon the sum of all the movements, actions, and reactions of characters known as the organism and upon all single characters [which happen to be] of survival or elimination value."

Finally, I cannot lend the least shadow of assent, as my reviewer states I do, to the recent enunciation by Prof. Bateson that we may have to forgo the theory of addition of germinal determiners and substitute a theory of evolution by loss of determiners. On the contrary, I expressly state that while palæontology offers the most positive testimony as to evolution by the loss of certain somatic characters, such as in the side digits of the horse (of which, by the way, most of the germinal determiners still persist), the law of incessant additions of new numerical and proportional characters such as transform the Eocene into the modern mammals certainly does not accord with Bateson's metaphysical conception that this outward progress and development may represent an inward loss of germinal determiners. The defect in Bateson's reasoning arises from the fact that in his special field of investigation the new laws and principles established in palæontology are not observable at all.

Of the three kinds of mammals mentioned above the group at present revealing the most complete and unbroken history is the titanothere family, which I have been engaged in monographing during the past fifteen years for the United States Geological Survey. The most significant result derived from the intensive study of the evolution of this family is the law of multiple-character evolution, namely, that evolution simultaneously progresses in every one of the innumerable single characters of which an organism is composed. Each character possesses its own individuality and separableness, each advances or lags behind according to its individual velocity, each subserves the general purpose of the entire organism through the uniting forces which we term correlation.

While writing, I would like also to correct an erroneous impression, for which my present reviewer is not at all responsible, as to my viewpoint regarding Lamarckism. In 1889 I held that the reaction-inheritance hypothesis of Lamarck was the only explanation we have for such directive or orthogenetic tendencies in evolution as are displayed especially in the origin of characters which I have termed "rectigradations." I subsequently—with Baldwin and Lloyd Morgan—discovered the organic-selection principle and abandoned the reaction-inheritance interpretation when I observed that while it may explain certain orthogenetic tendencies, it is directly contrary to others. Thus I am to-day in no sense a Lamarckian.

All that we can positively state at present is that the adaptive trend in the origin of new specific and generic characters is the resultant of the interactions of four sets of forces: germinal, environmental, ontogenetic, and selective, as expressed in the law of "tetraplasy." We know that these "actions," to quote Newton's phrase, are in continuous operation. We also know that in certain cases one or other of these four complexes of forces may be dominant, so that the visible changes which we observe in animals and plants may for a time be chiefly either ontogenic, or environmental, or germinal, or selective. But what may be the nature of the interactions between ontogenic, environmental, and selective forces on the germ-chromatin and the continuous origin of new adaptive characters in the germ-chromatin we have not as yet the most remote conception.

Finally, the chief purpose of my address was to show the real harmony which exists between the actual observations of palæontologists and of experimentalists and the distinctive principles which are most readily observed in these respective fields of research. HENRY FAIRFIELD OSBORN.

Columbia University, September 29.

PROF. OSBORN would have earned the gratitude of us all if he had produced some evidence in support of his assertion that "there is a clear genetic distinction between 'numerical' and 'proportional' characters." We still maintain that this connection cannot be demonstrated.

Neither can the reviewer admit that he has failed to understand Prof. Osborn's observations regarding the nature of species and genera. In the first place, Prof. Osborn's interpretation of the "Darwinian tradition," which he emphasises in this protest, is inadmissible, since it involves the assumption that the evolution of species manifests itself suddenly "in one character or group of characters." From his context he implies that according to this "tradition" a species, A, may give rise to species B, C, and D, each differ-

ing from the other in sharply-defined characters, which, being products of the germ-plasm, are transmissible, though they may be eliminated by selection. He contrasts this view, which is *not* according to the Darwinian tradition as commonly accepted, with his own—which is entirely "Darwinian"—based on osteological characters according to which the evolution of species is quite otherwise, demonstrating a condition of continuous development to be traced by means of, say, a horn or the cusp of a tooth; or, in other words, on "characters which happen to be so conspicuous as to attract the eye of the zoologist."

Having disposed of the Darwinian "tradition," he proceeds to point out a more excellent way of interpreting the mazes of evolution, and this by means of a "newly-discovered law of multiple-evolution" derived from the discoveries of palæontology, which "proves" that "every organism is made up of an almost infinite number of characters, each of which is in a continuous state of movement, either originative, progressive, or retrogressive." But this idea of "multiple-character evolution" cannot fairly be said to be new. Further, if Prof. Osborn has independently arrived at this conception of evolution, he has done so through his own wide knowledge of living animals, and not entirely, as he seems to believe, through his brilliant discoveries in palæontology. Palæontology, in short, cannot be said to "prove" that every organism is made up of an infinite number of characters . . ." for palæontology can "prove" no more than can be attested by such skeletal and dermal structures as are capable of fossilisation. The characters furnished by musculature, viscera, "behaviour," and the "emotions," for example, are all factors of evolution which can only be imperfectly inferred, not demonstrated, by the palæontologist.

In stating that Prof. Osborn could find "no evidence whatever in support of the theory that species may arise from fortuitous, saltatory characters," the reviewer felt that he was accurately interpreting Prof. Osborn's assurance that he did not "know of a single instance where the field observer in mammalogy or palæontology has recorded a new saltatorial character which is known to be of any significance to the race." Prof. Osborn's reference to teratological cases does not seem to help him.

The reviewer frankly admits that he was wrong in suggesting that Prof. Osborn was to be regarded as in sympathy with the theory of evolution by loss of characters.

THE REVIEWER.

Simple Device for Controlling the Movements of Paramœcia.

EVERYONE who is concerned in the teaching of elementary zoology knows the great difficulty of so controlling the movements of Paramœcium that students can distinguish the essential features of its structure. Of all the methods adopted for this purpose of which I have hitherto heard, none has ever given me such successful results as one which I tried recently in this department as an experiment, and the advantages of which combine simplicity with very great control over the animals.

A small quantity of ordinary gum is painted on a glass slide, and allowed to become nearly dry; a drop of water containing the Paramœcia is then placed on the gum and covered in the ordinary way with a cover-glass. At first the gum will scarcely interfere with the movements of the animals at all, but within a few minutes, as the gum diffuses through the water, they will be seen to move more and more slowly, and ultimately they will be unable to move at all. Finally, the irritation caused by the gum will result in the discharge of the trichocysts.

This method of using the gum enables the student to observe the Paramœcia at first in an almost normal condition, and afterwards to make a careful and detailed examination of them at his leisure. The normal shape and appearance are retained for a long time, even when the animal has become stationary, save that the gullet tends gradually to disappear, possibly through clogging with the gum.

R. W. HAROLD ROW.

Zoological Department, King's College (University of London), November 8.

MONUMENTS AND LIGHTNING.

THE liability of monuments to be struck by lightning is the subject of a recent memoir in the *Atti della Pontificia Accademia dei Nuovi Lincei* by Prof. Ignazio Galli. The occasion of this note was the destruction at Santamaria di Capua Vetere, in the province of Caserta, in October, 1914, of a fine monument erected in 1895 in memory of the battle fought near to Volturno in 1860. This monument of travertine marble, about 95 feet high, consisted of a stately column on a substantial pedestal, surmounted by a colossal bronze statue of Victory about 10 feet high, weighing 1500 pounds. This statue was fixed in the summit of the column by an iron rod which penetrated about half-way down the column. The monument stood in the quadrangle of the communal building, far from any high trees. During a violent thunderstorm about 2 a.m. a lightning stroke threw down the great bronze statue, and destroyed the upper half of the column. It is thought that the destruction might have been averted had an efficient metallic conductor connected the bottom of the iron rod to a damp stratum of soil. It is evident that an insulating mass of marble, many feet high, between a metal object and the earth affords no protection whatever against a severe thunder-stroke.

Prof. Galli takes occasion to refer to similar catastrophes which befell a column at Constantinople in the year 548, and another dedicated to Constantine the Great in the same city in the year 1101. In Rome in the fourteenth century the column of Marcus Aurelius Antoninus was badly damaged at the top; and in the same century the statue of Trajan on the summit of the celebrated column of Trajan was likewise destroyed. Tacitus records how in the year 61 A.D. the Baths of Nero, erected scarcely one year before, were destroyed by lightning. More recent times have witnessed the destruction of the tower of the Castello of Milan (1521), that of Ivrea (1676), of San Nazaro at Brescia (1769), and of the fortress of the Lido at Venice (1808). In 1572 the flagstaff of the Castle of St. Angelo in Rome was destroyed, with the bronze statue of the Archangel Michael. Between the years 1606 and 1809 the basilica of St. Peter's was struck, generally on the cross or the golden ball, at least twenty-two times. On the last occasion (1809) the Pope, Pius VII., had already begun preparations for fixing lightning conductors. For more than a whole century these conductors have effectually preserved the structure from damage.

PERSIA.[1]

COL. SYKES has long won a position of authority and distinction in Persian questions by his travels and studies, including the well-known "Ten Thousand Miles in Persia," an "ouvrage couronné" (by the Royal Geographical Society) more than ten years ago. But for many years he has cherished the idea of a Persian history, only now fulfilled—the crown of his labours. Sir John Malcolm's "History of Persia from the most Early Period to the Present Time" appeared in 1815, and since that time no English Orientalist has attempted the same task on a similar, or adequate, scale. Sir Clements Markham's useful "Sketch of the History of Persia" (1874) does not claim to come into the comparison—excellent as it is. Since Malcolm's work, a century ago, the field of investigation has been transformed; mines of buried treasure have shown something more than "neglected agricultural land." The cuneiform inscriptions have been deciphered; such records as the cylinder of Cyrus and the Behistun record of Darius have been discovered and interpreted; historic sites have been excavated; we have in a measure evoked the spirit of ancient Persia. The modern world is now in a position to understand to some degree the Persian side in the struggle with Hellas and with Rome, and to revise old notions, based exclusively upon Western information and Western views. Ancient Persia can no longer be treated as a mere barbaric despotism, which has contributed nothing to civilisation.

Col. Sykes has special advantages from his close personal knowledge of so much of the ground; for twenty-one years he has lived in Persia; as a diplomatist, a soldier, a traveller, and a student he has seen the Middle East from various sides and penetrated many disguises. Peculiarly good, among many good things, are the geographical and topographical sections and references, such as the chapters that introduce the work ("Configuration, Climate," etc.), and the constant elucidations of history through the personal wanderings and investigations of the writer. Archæology and topography are well combined in the account of the great ruined sites of Achæmenian and Sasanid Persia, and the history of culture is not forgotten in the sections given to Persian customs, language, letters, and art, in various periods.

This book seems to give a fresh interest and value to the time of early Persian greatness—from the rise of Cyrus to the death of Darius Hystaspes—as well as to that attractive and neglected subject of the Sasanid kingdom, where "Asiatic slaves" appear struggling so long and so successfully against the Far Eastern expansion of Rome. The whole subject of Zoroaster and fire worship is sympathetically treated, and one may learn much of Old Persian architecture, art, and poetry from these pages.

In the Abbasid period of Muhammadan rule the author well develops the subject of Persian influence—so notably revived, after a time of deep depression, by the overthrow of the Umayyads and the transference of the capital from Syrian Damascus to Baghdad on the Tigris. The reader may be referred to the forty-ninth, fiftieth, and fifty-fourth chapters: "Persian Ascendancy in the Early Abbasid Period," "The Golden Age of Islam," and "Persian Literature before the Mongol Invasion," some of the most interesting and valuable in this work.

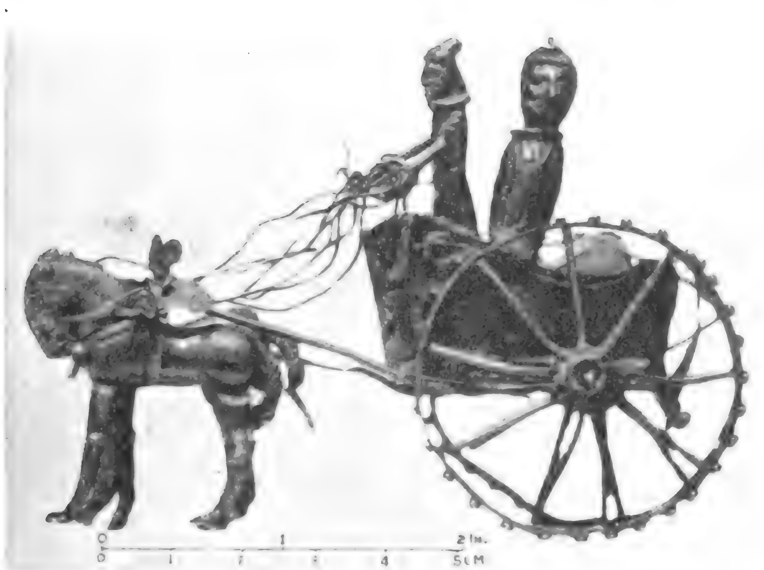

FIG. 1.—Gold model of Achæmenian chariot. (From "Treasure of the Oxus.") From "A History of Persia."

The Mongol Ilkhanate of Persia, in its political history, might perhaps have been made more of (except for the reign of the ugly and glorious dwarf, Ghazan, which is fully appreciated); on the other hand, the survey of Persian literature and art under the Mongols is very useful. But no part of this history is more serviceable, for none fills a more evident want, than the picture of the rise and fortunes of the new independent Shiite Persia, after the fall of the Timurids, in the sixteenth century. Of few parts of Persian story is it perhaps more difficult to gain really good information and criticism; of few parts is there more general ignorance.

The illustrations, by themselves, are noteworthy, and place us under a debt to the author, who has furnished many from his own collections and photographs. Some excellent things come

1 "A History of Persia." By Lieut.-Col. P. M. Sykes. Vol. i., pp. xxvi +544. Vol. ii., pp. xxii+565. (London: Macmillan and Co., Ltd., 1915.) Price 50s. net, two volumes.

from Hommaire de Hell's "Voyage en Turquie et en Perse," Layard's "Nineveh," J. de Morgan's "Délégation en Perse," Dieulafoy's "L'Acropole de Suse" and "L'Art antique de la Perse," the "Treasure of the Oxus," and Martin's "Miniature Painting in Persia"; Vereshchagin's pictures of Russian Central Asia have also been laid under contribution; and the author's industry and enthusiasm have collected treasures from many other sources. Besides the headpieces of the chapters, reproducing early coins, seals, gems, medallions, vases, cylinders, inscriptions, armour, and scenes of war, chase, and agriculture, more than 160 full-page designs, some in colour, are true illustrations of an admirable work. The seven maps are perhaps somewhat less pleasing and effective, though mostly of good average merit; that of Central Asia, facing p. 84, vol. ii., leaves one cold; that showing the Persian provinces, under the Abbasids, vol. ii., p. 62, is perhaps the best. Some of the pictures (among which, of course, none are "fancy") are of striking beauty, interest, or clearness: one might instance the "Ararat" of vol. i., p. 4, the "Friezes of the Archers," and "Lions" at Susa, facing pp. 58 and 194 in the same volume; the photographs of Bandar Abbas, Yazd, and Kirman, by H. R. Sykes, in vol. ii.; the specimen chariot of the First Persian Empire (i., 150), the tomb of Cyrus (i., 164), the captivity of Valerian in the hands of Shapur (i., 432), the tomb of Timur (ii., 214), and several of the author's own photographs (*e.g.*, ii., 340, 342).

It is perhaps open to criticism that so much space has been given to early Oriental matters before Cyrus, and that such deep digressions are sometimes made into external history of later time, well away from the main subject (see chaps. 4–7, 20, 44–6). The comparative value of the great figures of the Persian stage may be sometimes overrated; even Alexander of Macedon is perhaps a case of this. One could wish that Col. Sykes had given the Behistun inscription in full. In his picture of Zoroastrianism he scarcely seems to allow sufficiently for shadow as well as light, for readiness to persecute as well as for "good thoughts, good words, good deeds" (*Humata, Hukhta, Hvarshta*). It was not merely from the Church of Rome, but from the Catholic Communion in East and West that the Nestorians broke off. But the whole book is delightful, and one cannot but hope that it will be widely read and carefully studied; it is sure to be enjoyed.

FIG. 2.—Kupkan, the home of Imam Kuli. From "A History of Persia."

THE SAN FRANCISCO MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

SINCE the American Association, in 1902, definitely changed the date of its regular meetings to mid-winter it has, prior to the present year, held two summer meetings—one in Ithaca,

at Cornell University, in June, 1906, and one in Hanover, at Dartmouth College, in June, 1908. During the past summer advantage was taken of the World's Fair at San Francisco and the celebration of the completion of the Panama Canal to hold the first Pacific Coast meeting at San Francisco, Stanford University and the University of California, under the presidency of Dr. W. W. Campbell, director of the Lick Observatory of the University of California, at Mount Hamilton.

The meeting opened on Monday, August 2, with addresses of welcome by Mr. W. H. Crocker, first vice-president of the International Exposition, Dr. B. I. Wheeler, president of the University of California, and Dr. D. S. Jordan, chancellor of the Leland Stanford Junior University. Prof. H. F. Osborn, of the American Museum of Natural History, responded on behalf of the Association, and Dr. Campbell delivered an address entitled "Science and Civilisation."

The sessions of the different sections of the association and of the affiliated societies were held on Tuesday, Thursday, Friday, and Saturday of the same week in the buildings of the University of California, at Berkeley (across San Francisco Bay), and the sessions of Wednesday were held at Leland Stanford Junior University, at Palo Alto, an hour away from San Francisco by rail. On Monday evening a general reception to visiting members was held in the California Building on the Exposition grounds at San Francisco. On Tuesday, Thursday, and Friday public addresses were given as follows: Tuesday, by Prof. R. A. Daly, of Harvard University, on problems of the Pacific Islands; Thursday, by Prof. W. B. Scott, of Princeton University, on the isthmus of Panama and its influence on the animal life of North and South America; Friday, by Prof. P. S. Reinsch, American Ambassador to China, on the economic future of the Pacific.

The following affiliated societies held meetings: American Mathematical Society, Astronomical and Astrophysical Society of America, American Physical Society, Geological Society of America, Paleontological Society of America, Seismological Society of America, American Society of Naturalists, American Society of Zoologists, Entomological Society of America, American Association of Economic Entomologists, American Phytopathological Society, American Fern Society, American Psychological Association, American Anthropological Association, Archæological Institute of America, and the American Genetic Association.

Many excursions to points of scientific interest on the Pacific Coast were given. About six hundred members were in attendance. All the arrangements for the meetings were in the hands of the newly-organised Pacific Coast division of the American Association, which prepared a source book of information upon the natural aspects of the Pacific Coast and upon the developments which have given to the Pacific Coast its peculiar interest. It has been published under the title of "Nature and Science on the Pacific Coast."

Several interesting and rather important symposia were held, notably one on the physics of the air, under the auspices of Section B and the American Physical Society; three on the correlation of the Triassic, the Cretaceous, and the Miocene, under the auspices of the Paleontological Society of America; and one by the American Society of Zoologists on the *rôle* of variation and heredity in evolution. An important series of papers was presented by the Botanical Society of America on the geographic distribution of plants. A symposium was also held by the Educational Section of the Association and the American Association for the Study of the Feeble-Minded on the subject of mental tests and their pedagogical significance. The American Anthropological Association brought together a series of papers on the history of civilisation in the Pacific area and another on the social aspects of race factors in the Pacific area.

SIR ARTHUR RÜCKER, F.R.S.

ON Thursday last, in the afternoon of a still November day, amidst the russet and gold of the dying year, all that was mortal of a high-minded, courteous, cultured man—the true type of an English gentleman—Sir Arthur Rücker, a very "gentle knight" indeed, was committed to earth in the graveyard of the Berkshire village church in which for some years back, and so long as his waning strength permitted, he was accustomed to worship. His end came peacefully, for he died in sleep, apparently without pain, and so quietly that it was hard to realise that his beautiful spirit had indeed passed away. He had borne with characteristic courage, patiently and uncomplainingly, an illness which he well knew to be mortal. Although one of the most modest of men, he must have realised that he had made of his life a great success, for almost every mark of appreciation and esteem that can fall to the lot of a man of science had been accorded to him. It was but natural, therefore, that when freed from the cares and responsibilities of a high position, and with an ample competency, he should have looked forward to years of a dignified leisure in which to resume his studies and to follow the pursuits of the country life he loved so well. But it was not to be. He had barely taken off his harness when signs of the fatal malady made themselves manifest. Yet no embittered word or complaint ever escaped him, and he met the inevitable end with the calmness, resignation, and fortitude of a martyr.

Born in 1848, at the time of his death he had just completed his sixty-seventh year. He was the eldest son of Mr. D. H. Rücker, a City merchant living at Errington, Clapham Park. I was privileged to see a little of the home-life at Errington, and I recall the head of the house as a polished, courtly gentleman with a benign manner, reminiscent of Addison's worthy knight, and I well remember, too, the pleasing deference and affectionate respect with which father and son regarded and addressed each other. The family

was of Hamburg origin, but had been settled in this country for generations. Another branch had given a professor to the University of Leyden, and his portrait is to be seen in the senate house.

Arthur William Rücker received his early education at the Clapham Grammar School, at one time under the direction of the Rev. Charles Pritchard, F.R.S., who subsequently became Savilian Professor of Astronomy at Oxford. Here Rücker gained that grounding in mathematics to which much of his success as a teacher and investigator was due. From Clapham he proceeded to Oxford, and was entered at Brasenose. After a brilliant career as an undergraduate, with special distinction in mathematics, he was elected a fellow and lecturer of his college, and became demonstrator of physics in the Clarendon Laboratory. Oxford made a deep and lasting impression upon Rücker, apart from her effect upon his career as a man of science, for he came there under influences which profoundly affected his religious convictions and shaped the whole course of his spiritual life. He seldom cared to speak of sacred matters even to his most intimate friends, but to those who were admitted to his confidence it was evident how much he realised he owed to his Alma Mater in this respect and with what grateful affection he regarded her.

My acquaintance with Rücker dated from 1874. In that year we, together with the late Professor Green, who afterwards occupied the chair of geology at Oxford, were elected as the first teachers in the newly-created Yorkshire College, Leeds—Rücker as professor of mathematics and physics. Its habitation at that time was in the disused Bankruptcy Court, a somewhat woebegone, ill-constructed building which, after a checkered career, had been turned into a school of cookery. Unfortunately the gastronomic experiments of the pupils had succeeded in setting fire to the place, and my first meeting with Rücker was over the charred beams of the principal room. The spectacle that this prospective seat of science and learning then presented seemed sorrowful enough, but, nevertheless, to the budding professors it had in it a certain element of humour. As we could not hear of any students, the circumstance that there was no proper place in which to teach them was not, perhaps, of pressing importance. But Yorkshire grit and energy soon got the place into something like shape. The old court-room was eventually converted into a fairly good lecture theatre; there was laboratory accommodation for about a couple of dozen workers, two or three small classrooms, with some provision of what were euphemistically termed professors' private rooms. At length we were able to make a belated start with as many students as could be counted upon the fingers of one hand. Such was the beginning of the institution which has developed into the University of Leeds, with an eminent professoriate in numerous faculties, housed in handsome buildings, with well-equipped laboratories, workshops, and classrooms, spacious libraries and museums, a long roll of graduates in arts and science, and an annual entry of many hundreds of students of both sexes. Towards this consummation Rücker worked unremittingly. From the outset he threw himself heartily into the intellectual life of Leeds, was an active member of its Literary and Philosophical Society, and became associated with certain of the educational organisations in the district. His energy, capacity, soundness of judgment, and business aptitude were soon appreciated by his colleagues, and quickly gained for him the complete confidence of the governing body. Moreover, he developed into an excellent teacher. He was an admirable lecturer, with a remarkable power of exposition and a gift of felicitous phrase, which, with a certain delicate, restrained sense of humour, made him delightful to listen to.

Rücker never took any very strong interest in mere party politics, but as a young man his political sympathies were distinctly Liberal. Nothing, perhaps, more strikingly illustrates the influence and position he acquired in the town than the fact that in the election of 1885 the party managers should have invited him to contest North Leeds, a Conservative stronghold, and then reckoned a safe seat for Mr. Lawies Jackson, now Lord Allerton. It was one of the most strenuous contests ever fought in that division, Rücker being beaten by only 257 votes on a poll of nearly 9000. In the following year came the great Disruption, and Rücker as a Liberal Unionist unsuccessfully fought the Pudsey division.

Somewhat to the surprise of his colleagues, and greatly to their regret, he now severed his connection with the college. Thanks in a large measure to his untiring efforts, his constructive ability and skill in negotiation, he had seen the institution raised to the rank of a constituent college of the Victoria University, and thanks also largely to his influence with the governing body, it was now in a habitation worthy of its position. With no immediate prospect of entering public or political life, he returned to London and again took up his residence with his parents at Clapham.

In the following year I followed him as successor to the late Sir Edward Frankland in the Normal School of Science, South Kensington. On the death of Prof. Guthrie in 1886, I succeeded in inducing Rücker to reconsider his decision to abandon the career of a teacher, and with the cordial concurrence of Huxley, then dean of the School, and of the authorities of the Science and Art Department, he was invited to occupy the vacant chair of physics, and he resumed what really was his true vocation with all the energy, ability, and success that had attended his work in Leeds. At South Kensington, as at Leeds, it became our duty, by direction of the authorities, to prepare plans for a considerable extension of the laboratories and classrooms of the Royal College of Science, and to Rücker's thoughtful prevision, experience and mastery of detail, combined with the planning of Sir Aston Webb, the present admirable physical laboratories of the

Imperial College of Science and Technology are due.

In 1901 Rücker was induced to accept the principalship of the reorganised University of London. He had been a member of the old senate since 1890, and had acquired an intimate knowledge of the working of the University, its aims, and somewhat divergent policy. In undertaking the principalship he undoubtedly entered upon the most difficult and most arduous position he was ever called upon to fill. To a man of less courage, tact, and patience his situation would at times have been intolerable. He had very definite views, based upon knowledge and a ripe experience of the true functions of a great metropolitan University, and had on several occasions, both in speech and in writing, given public utterance to them. But as a man of affairs, accustomed to the conflict of discordant aims and the clash of vested interests, no one knew better how often in this imperfect world the better is the enemy of the good. No one was more ready to appreciate the strength of an opponent's position or to realise the value of compromise, and his sympathy, his sense of fairness, his unfailing courtesy, and his skill in diplomacy constantly enabled him to get the best out of a compromise. To his intimate friends he had communicated his intention of resigning his position when he should have reached his three-score years. During the seven years he held it he had the satisfaction of bringing about the incorporation, as constituent parts of the University, of the two leading London colleges, with the consequent strengthening of the internal side. He gave up his office to the great regret of all who served with or under him, and with a unanimity in expression of good-will, esteem, and friendship from all sections which greatly touched him at the time, and of which he had a grateful recollection.

Rücker was elected into the Royal Society in 1884, was a member of council in 1887–89, and again in 1894, when he became one of the secretaries. No man ever filled that office with greater acceptance. During the five years he held it he brought to the exercise of its duties the same habits of industry and the same mental and personal characteristics that had marked his discharge of every position he had undertaken.

In 1891 he became treasurer of the British Association, in 1898 a trustee, and in 1901 president. He took an active share in the formation of the Physical Society, served on its council, and was its president in 1893–95.

Rücker, as might be supposed, was frequently called upon to serve upon Royal Commissions and Departmental Committees, and much of his time and energy was spent in such public service. He was a member of the Royal Commission on Irish Universities in 1906; on the University of Belfast Commission in 1908, in which year he was also placed on the Carnegie Trust for the Scottish Universities. He was a member of the Board of Trade Committee on Sight Tests in 1910, and of the Royal Commission of the 1851 Exhibition in 1911. He acted as deputy chairman of Lord Rayleigh's Committee which led to the foundation of the National Physical Laboratory; he served on its governing body, and, so long as the state of his health permitted, took an active interest in its development.

Rücker's list of scientific papers is comparatively short, and it cannot be said that he has left any marked impression upon British physics. There can be no question, however, that he possessed all the essential attributes of a successful investigator. But, as it happened, circumstances, not always of his choosing, placed him in positions in which his time, energy, and mental powers were practically wholly absorbed by matters unconnected, or at most only indirectly connected, with physical inquiry. At the same time he was keenly interested in the progress of science, and was an omnivorous reader of contemporary scientific literature. It was easy to engage his attention and to excite his interest in any problem which he thought his knowledge or mathematical ability might possibly elucidate. Some of his early papers were joint productions on subjects of physical chemistry contributed by us to the Journal of the Chemical Society. On one occasion he was induced to address the society on the Range of Molecular Forces (published in the Transactions for 1888), in which he incidentally gave an account of the joint work of Prof. Reinold and himself on "The Properties of Liquid-films" (Phil. Trans., 1881 and 1886).

But Rücker's chief contribution to science was his share—and it was by far the more important share—in the Magnetic Survey of the British Isles for the epochs 1886 and 1891, the results of which were published in their final form in 1896 as a separate volume (vol. clxxxviii) of the Philosophical Transactions. Space precludes any attempt to tell the story of how the Survey originated and how Rücker was induced to take an active interest in Terrestrial Magnetism. He showed himself an excellent observer, and became very expert in the use of the Kew pattern of magnetometer in the field, where, in a variable climate like ours, it is frequently necessary to be prompt as well as accurate. He organised the whole of the tedious work of reduction, checking, and tabulation, and upon him fell the chief burden of putting together the outcome of our discussions of the results. The first memoir was made the Bakerian Lecture for 1889, and the Society indicated its high appreciation of Rücker's work by recommending him for a Royal Medal in 1891. It is but just to him to say that the memoir in which he embodied the results of our joint labours, extending over some fourteen years, marks a new departure in work of this kind, and that its influence is plainly evident in similar surveys which have been subsequently carried out in various parts of the world.

Rücker was married twice. His first wife was Marian, daughter of Dr. J. D. Heaton, F.R.C.P., the first chairman of council of the Yorkshire College. She died in 1878, leaving a daughter, now Mrs. Reginald Hooker. His second wife, whom he married in 1892, is Thereza, daughter

of the late Prof. Story-Maskelyne, F.R.S., of Basset Down, Swindon. They have one son, Nevil, who, after doing duty in the Secretary's Department of the War Office shortly after the outbreak of the war, is now on active service.

T. E. THORPE.

NOTES.

WE regret to learn that Dr. Theodor Boveri, professor of zoology and comparative anatomy in the University of Würzburg, died there, after a long illness, on October 15, at fifty-three years of age.

THE death occurred on November 5, at sixty-three years of age, of Mr. J. Sinclair, editor of the *Live Stock Journal* and the *Agricultural Gazette*, and author and editor of many standard works on stock-breeding and agriculture.

WE learn from *Science* that Prof. Augustus J. Du Bois, for thirty years professor of civil engineering in the Sheffield Scientific School, Yale University, died on October 19, at the age of sixty-six years; and that the Rev. C. M. Charroppin, S.J., formerly head of the department of science of St. Louis University, died on October 17.

THE following have been elected officers of the Cambridge Philosophical Society for the ensuing session, 1915–16:—*President*: Prof. Newall. *Vice-Presidents*: Dr. Shipley, Dr. Fenton, Prof. Eddington. *Treasurer*: Prof. Hobson. *Secretaries*: Mr. A. Wood, Dr. Arber, Mr. G. H. Hardy. *New Members of the Council*: Dr. Bromwich, Dr. Doncaster, Mr. C. G. Lamb, Dr. Marr, Mr. J. E. Purvis.

AT the annual meeting of the Faraday Society on October 19 the following officers and members of council were elected to serve for the year 1915–16:—*President*: Sir Robert Hadfield. *Vice-Presidents*: Prof. K. Birkeland, Bertram Blount, W. R. Bousfield, K.C., Prof. F. G. Donnan, Dr. Eugene Haanel, Prof. A. K. Huntington, Dr. T. M. Lowry. *Treasurer*: Dr. F. Mollwo Perkin. *Council*: W. R. Cooper, Dr. C. H. Desch, Dr. J. A. Harker, Emil Hatschek, Cosmo Johns, Prof. A. W. Porter, E. H. Rayner, A. Gordon Salamon, Dr. G. Senter, Cav. Magg. E. Stassano.

A FURTHER appeal is made for the presentation or loan of telescopes for use with the batteries at the Front. Large telescopes on stands, deer-stalking telescopes, good pocket telescopes—in short, any type except toys are acceptable. Astronomical eye-pieces, etc., not wanted on service, are removed before issuing and marked with a number identical with that engraved on the telescope. Offers or instruments should be sent to the secretary, Lady Roberts's Field Glass Fund, National Service League, 72 Victoria Street, S.W.

IT has been found necessary to make certain alterations in the arrangements originally made for the London meetings of the Institution of Electrical Engineers. The revised programme for the immediate future is:—November 18, the inaugural address of the president, Mr. C. P. Sparks; November 25, "Some Difficulties of Design of High-speed Generators," by Prof. A. B. Field; December 16, "The Design of High-pressure Distributing Systems," by J. R. Beard; January 13, "The Predetermination of the Performance of Dynamo-Electric Machinery," by Prof. Miles Walker; January 20, "The Possibilities in the Design of Continuous-current Traction Motors," by N. W. Storer.

THE President of the Board of Agriculture and Fisheries has appointed a Departmental Committee to make arrangements with a view to the maintenance, so far as possible, of adequate supplies of fertilisers for the use of farmers in the United Kingdom. The Committee is constituted as follows:—The Right Hon. F. D. Acland, Parliamentary Secretary to the Board of Agriculture and Fisheries (chairman); Mr. R. H. Rew, Board of Agriculture and Fisheries; Mr. T. H. Middleton, Board of Agriculture and Fisheries; Mr. G. J. Stanley, Board of Trade; Mr. J. Dundas White, Scottish Office; Mr. H. Ross Skinner, Ministry of Munitions; Mr. E. J. Foley, Admiralty; Mr. R. J. Thompson, Board of Agriculture and Fisheries. The secretary of the Committee is Mr. H. D. Vigor, 3 St. James's Square, London, S.W.

THE death is announced of Dr. Gaston Vasseur, professor of geology in the University of Marseilles, at the age of sixty years. His early works on the Tertiary formations of the Paris basin and the west of France placed him in the first rank of French stratigraphical geologists, and for many years he was employed by the Geological Survey of France in preparing the detailed map of the south-western area, which he had the satisfaction of completing. He also published as an independent work an important geological map of the whole of France. During the progress of his researches in the field he amassed a great collection of fossils, now in the museum of Marseilles, where it still awaits detailed study and description.

THE death is announced of Dr. C. J. Bouchard, professor of pathology in the University of Paris. Born in 1837, Prof. Bouchard received the early part of his medical education at the Lyons Medical School before entering the faculty of medicine of the University of Paris, where he graduated in 1866. He was appointed professor of pathology in the University of Paris in 1873, afterwards acting as dean of the faculty of medicine. In 1887 he became a member of the Institut, and later an officer of the Legion of Honour and president of the Academy of Sciences. He laboured devotedly for more than fifty years at clinical medicine and general pathology, conducting research work which in many directions materially influenced the course of practical therapeutics. He worked upon ptomaine poisoning and autointoxication, on the functions of the leucocytes, on the pathology of nutrition, on the bactericidal power of the blood, immunisation and vaccination, on radiology, and on many of the problems of tuberculosis. He published several works, including a justly popular text-book of pathology. He took a considerable part in bringing about friendly relations between French and British doctors, and was chairman of the committee which organised the visit of British

medical men to Paris in 1905. Prof. Bouchard was held in high regard in France and abroad, and his death will be generally regretted.

By the death of Lieut. Gordon Sanderson, killed in France on October 13, the Archæological Survey of India has lost the services of a young officer of great promise. Mr. Sanderson was born in 1886, and, after serving for a time in the Egyptian Public Works Department, was appointed in 1910 an assistant superintendent in the eastern circle of the Archæological Survey of India. At the end of 1911 he was transferred to the northern circle as officiating superintendent of Muhammadan and British Monuments, while Dr. Ph. Vogel was acting general superintendent in the absence of Mr. Marshall. His appointment was confirmed in March, 1912. At the beginning of the present year he received permission to transfer to the military department, and was attached to the 2nd Batt. 2nd Gurkhas. Mr. Sanderson's work in the northern circle was especially concerned with the conservation of the important examples of Mughal art in Delhi, Agra, and Lahore. Some few years ago, arrangements were made whereby the royal palaces, which had been used as barracks, were evacuated by the military authorities and handed over to the survey. Mr. Sanderson ably continued the work of restoration made possible by the transfer. Its progress was announced from time to time in his contributions to the annual reports of the survey. These included a description of the Shāh Burj, a pavilion built by Shah Jehan, and restored by the late Mr. Froude Tucker in 1908, a report on conservation in Agra and the neighbourhood, and an account of Shāh Jehan's Fort at Delhi, in which his powers of lucid description were ably seconded by his skill as a draughtsman.

With much regret we announce the death of Mr. Donald Ewen, who was killed while tending the wounded between the lines near Loos about a fortnight ago. Mr. Ewen was serving at the time as a private in the London Scottish Regiment, but an order for his recall, to take up important work at the National Physical Laboratory, had been issued by the War Office; he is thus another of those sad cases where a promising young man of science, who was to have returned home for important work, has been killed just before the order was to be carried out. Mr. Ewen was born in Birmingham in 1887, and educated at Oundle School and Birmingham University, taking his M.Sc. in metallurgy in 1910, and gaining the Wiggin and Bowen research scholarships. He then entered the National Physical Laboratory, where he was to attain the grade of assistant on his return from France. He published many papers on metallurgical subjects, collaborating with Prof. T. Turner, of Birmingham, and, more recently, with Dr. W. Rosenhain, of the National Physical Laboratory. The latter papers dealt principally with the hypothesis of the existence in metals of an amorphous intercrystalline cement, and Mr. Ewen's careful experimental work did much to establish the theory as a well-based working hypothesis. His death is to be regretted, not only as that of a cheerful and enthusiastic personality, but also as a research worker in a field that urgently needs cultivation, and one from whom further important contributions to metallurgical science might well have been expected.

Capt. W. Loring, of the 2nd Scottish Horse, who died on a hospital ship on October 24, from wounds received at the Dardanelles, had in earlier years done distinguished work in classical archæology. After a brilliant career at Eton and Cambridge, he went out in 1889 as a student of the British School at Athens, and for the three following years remained at the school as Craven student. During that period he took an active part in excavations, notably in those at Megalopolis, besides undertaking on his own account a complete topographical survey of Arcadia. When he settled in London, as an examiner in the Board of Education, he held for a time the post of secretary to the school at Athens, and it was during this period that he volunteered for service in South Africa, first as a trooper in a yeomanry regiment, and then with a commission in the Scottish Horse. He was severely wounded, was twice mentioned in despatches, and received the Distinguished Conduct Medal. He left the service of the Board, where he had been private secretary to Sir John Gorst and Sir William Anson, in order to become director of education under the Education Committee for the West Riding of Yorkshire, but vacated the post through a difference of opinion with his committee, and about a year later, in 1905, became warden of the Goldsmiths' College, New Cross, a post he held until his death. He had always kept in touch with the Scottish Horse, and when the present war broke out he at once rejoined the colours, and after a year's training in England went out to the Dardanelles with the regiment in August last. In Capt. Loring the country has lost a man of real ability, of remarkable force of character, and single-hearted devotion to duty.

With the passing away of Prof. James McCall, principal of the Glasgow Veterinary College, on November 1, at the advanced age of eighty-one years, veterinary science has lost one of its greatest and most highly esteemed exponents. Educated at Wallacetown and Ayr Academies, he was intended for the legal profession, but that work did not prove congenial. Consequently he soon deserted it, and enrolled as a student at the Dick Veterinary College, Edinburgh, where he qualified as a member of the Royal College of Veterinary Surgeons in 1860, and afterwards obtained his fellowship in 1877. His enthusiasm for the progress of veterinary science enabled him to overcome opposition on the part of existing veterinary colleges when he applied for a charter for the establishment of the Veterinary College of Glasgow in 1862. The charter was, however, granted and signed by the late Queen Victoria in 1863. From that time the college has steadily progressed, and has been transformed from a private to a public incorporated institution, approved and supported by the Scotch Education Department, the powers of which have now been transferred to the Board of Agriculture for Scotland. The alumni of the institution include some of the most notable exponents of veterinary science, both in the British Isles and the Colonies,

and they are at one in attributing their success to the excellent teaching and example of the late principal. Prof. McCall was a man of action, and did not resort much to the pen. His outstanding abilities were early recognised by the Government and local authorities. He might be described as one of the pioneers of veterinary public health, recognising as he did the importance of veterinary inspection of meat and of dairies, and it was largely owing to him that Glasgow earned the distinction of being the first city to introduce the safeguard to public health on those lines. Amongst his professional honours, Prof. McCall was president of the Royal College of Veterinary Surgeons 1890–91, vice-president 1868–9, 1871, and 1873 to 1879, and member of the council 1884–95, and 1899–1915.

DR. SIDNEY COUPLAND'S Harveian oration, published in the *Lancet* of October 30, deserves careful study. Not that we need admire the existence of Harveian and Hunterian orations. It is absurd, thus to make immortality compulsory. There have been a hundred orations in memory of Hunter, and many more than a hundred in memory of Harvey. The result is, that the more courageous orators are venturing to hang their own special subjects on these two exalted pegs: so that we have a Hunterian oration on some new discovery which "would have interested Hunter," or on some new method of treament "not dreamed of in the days of Harvey." These monumental antiquated lectures ought to be on a different man each time—Vesalius, Paré, Jenner, Cooper, Darwin, Pasteur, Lister: a whole host of immortals are waiting their turn. But Harvey's life is always worth hearing of; he might be added to Hazlitt's list of people whom one would like to meet. He lived in wonderful times, and he was a man of great charm and distinction of character, apart from his mighty work in physiology. On Harvey's scientific work Dr. Coupland hangs his own authoritative subject, the pathology and the treatment of insanity. Nothing in all medicine and surgery is more worthy of note than the present materialistic study of "mental diseases." It is bound to give results of very great and lasting value; it is miles ahead of the old psychological talk, which was a sort of Linnean classifying; it has revolutionised our concepts of insanity, and it will provide new resources for the treatment of the insane. But if the men of science and the physicians are to do their best, they must have the help of public opinion. The old half-superstitious, half-sentimental terror and hatred of insanity must be put away—easier said than done, but worth doing—and we must all be prepared to support any good national plan which can be devised for the early detection, isolation, and treatment of incipient cases.

A NEW part of the Proceedings of the Prehistoric Society of East Anglia begins the second volume of the publications of this active society. Like the previous parts, it is well illustrated by plates and text-figures, chiefly of implements, and it deals with many subjects of more than local interest. In his presidential address Mr. J. Reid Moir returns to the question of flint implements found beneath the Red Crag of Suffolk; and in a subsequent paper he discusses a series of mineralised fragments of bone from below the base of the Red and Coralline Crags, which he considers to be implements of a primitive type made by man. A valuable account of the sub-Crag detritus bed itself is contributed by Mr. Alfred Bell. Mr. R. H. Chandler describes implements of the Les Eyzies type from a working floor in the Cray valley, Kent, and Mr. Henry Dewey discusses the surface changes since the Palæolithic period in Kent and Surrey. According to Mr. Dewey, "there can be no doubt that flint implements characteristic of widely different periods all occur together on the surface of the Kent and Surrey hills. The mere fact of their occurrence in considerable numbers suggests continuous occupation of the sites from early Palæolithic to late Neolithic times; and that no destructive agencies of sufficient power to remove them acted either during or since the time of their deposit."

REFERENCE has been made in these columns to the Economic Bulletins on "The House-fly as a Danger to Health" (No. 1), and "The Louse in its Relation to Disease" (No. 2), lately published by the trustees of the British Museum. An account, still more condensed, of "The Danger of Disease from Flies and Lice" has now been issued as a four-page Economic Leaflet (No. 1) by the trustees. The life-histories and habits of the insects are dealt with as effectively as possible in the small space allowed, and practical directions for their extermination or for the prevention of their infective activities are clearly given.

THE latest number (No. 2, of vol. vi.) of the Bulletin of Entomological Research is of larger size than usual, and contains at least three papers of importance. Prof. M. Bezzi describes with clear structural figures the Ethiopian fruit-flies of the genus Dacus. Mr. F. V. Theobald contributes part 2 of his enumeration of African Aphididæ, diagnosing and figuring many new species, and founding three new genera. It is of interest to know that common European species, such as *Macrosophum pisi, M. sonchi,* and *Lachnus viminalis,* are to be found in Egypt, and the first-named in British East Africa also. Incidentally, Mr. Theobald furnishes a table for the discrimination of all the rose-feeding aphids known to him. Mr. A. T. Stanton describes, with illustrations of external features, the larvæ of thirteen Malayan Anopheline mosquitoes.

A BULLETIN (No. 8, 1915) issued by the Department of Fisheries for the Indian provinces of Bengal and Bihar and Orissa deals with the statistics of fish caught during the year 1912–13. Mr. T. Southwell refers to the undoubted fact that the supply of fish in the United Province is diminishing. Fresh-water fisheries are certainly exhaustible, and in this case irrigation schemes have produced changes which have led to diminution of the natural resources. The remedy, he indicates, lies in artificial cultivation, basing this procedure upon the scientific knowledge of the natural history of the staple species now gradually being obtained by the Department. Artificial culture, he says, will not be a difficult task, but it will

be difficult so to organise this work that restocking of the rivers, *beels*, and tanks of the province may proceed rapidly under the new conditions. Economic difficulties will further hamper the improvement of the fisheries, but there is much hope for progress in the fact that the Department of Fisheries is a growing one, basing its administrative work upon a foundation of scientific investigation.

THE Gardens Bulletin of the Straits Settlements, No. 9, vol. i., contains among other notes three papers on yams, one of which, on the sprouting of the tubers of *Dioscorea alata*, is of general botanical interest. It has been known for some time that the tubers of yams sprout more quickly from the basal or older portions than from the younger, and that if a tuber be halved the shoots are usually produced towards the base of either half, and most quickly from the base of the oldest half. Mr. Burkill has made a careful series of experiments with tubers cut up into sets, and has recorded in tabular form the date of the appearance of the sprouts from the different sets. The results are in agreement with expectation, but it is found that different races vary considerably in the precocity or lateness of their sprouting.

MR. E. D. MERRILL continues his studies on Philippine botany in No. 4 of vol. x. of the *Philippine Journal of Science* with an account of the Anonaceæ of the islands. The family is well represented in the Philippines, and twenty-four new species are described in the present paper. The genus Papaulthia, recently described by Diels from material collected in New Guinea, is found to be represented in the Philippines by six species formerly included under Polyalthia and Unona. *Papaulthia mariannae*, described by Safford, from the Mariana Islands, is considered by Merrill to be the type of a new genus Guamia, allied to Oncodostigma rather than to Papaulthia. The genera Desmos, Dasymaschalon, Griffithianus, Meiogyne, and Pseuduvaria are also new to the flora of the islands.

THE issue of a catalogue by Messrs. J. Wheldon and Co., devoted exclusively to agriculture, serves as a reminder of the number and value of agricultural books that have appeared from time to time in this country, and particularly in the eighteenth and early nineteenth centuries. The catalogue includes the thirteenth-century Walter of Henley's "Husbandry" (1890 reprint), Fitzherbert's "Book of Husbandry" (Skeat's reprint), and typical works by most of the well-known writers that followed—Tusser, Blith, Ellis, Bradley, and, to come to the end of the eighteenth and beginning of the last century, Young and Marshall. Among the most interesting items are a long series of the Annals of Agriculture, a complete set of the octavo volumes describing the survey of England and Wales made by the Board of Agriculture during the years 1795–1815, and an almost complete set describing the Scotch survey. The prices serve to remind us that the old agricultural books are becoming scarcer; it is notorious that many of them have in the past found their way over to the United States. Indeed, the agricultural expert who has hitherto wanted to consult agricultural literature, either old or new, has had no little difficulty, and he has been very unfavourably situated in comparison with the chemist or the botanist, who could always go to the library of the Chemical, the Linnean, or the Royal Society. It is hoped that the new library at Rothamsted, when it is developed, will remedy this defect.

THE monthly meteorological charts of the North Atlantic appear with regularity, and contain much useful information. In the November issue an account is given of the severe cyclone which devastated the north side of Jamaica on August 12. Details are promised later, but from the information to hand it appears that the storm centre passed fifty miles north of Jamaica, after devastating the south of Haiti. On August 16 it reached Galveston, where the wind attained ninety miles an hour. The disturbance was fifteen hours in transit. On the 17th it passed south of Houston, and continued north-west. On the 18th it recurved in 32° N. 98° W., and proceeded towards the St. Lawrence valley, where it died out in about 47° N., 74° W. on August 23rd. All along its track, but especially in Texan ports, considerable damage was done, and many lives lost. The greater part of the banana plantations in Jamaica was destroyed, but the coconut trees seem in great measure to have escaped.

THE October number of the Journal of the Franklin Institute contains an article by Dr. H. E. Ives, of the Physical Laboratory of the United Gas Improvement Company of Philadephia, describing the apparatus he exhibited before the American Physical Society a year ago for simplifying photometry and placing it on a firmer physical basis. Light as one of the forms of radiation should be measured in ergs per second or in watts, and not in terms of an abitrary unit, like the lumen. The instruments for measuring radiation are, however, sensitive to radiations which produce only a partial or no luminous sensation in the average eye. It is therefore necessary to interpose between these instruments and the luminous source an absorbing substance which will transmit of each type of radiation a fraction proportional to the sensitiveness of the normal eye for that type. Such a substance combined with a thermopile or bolometer and a galvanometer would constitute an artificial eye, and the deflections of the galvanometer would be proportional to the light entering the eye. Dr. Ives recommends as the absorbing substance a layer one centimetre thick of a solution containing 60 grams cupric chloride, 14 cobalt ammonium sulphate, 1·9 potassium chromate, and 18 c.c. nitric acid to the litre. A layer of water 2 cm. thick should be interposed between the source and the solution.

AN interesting account of the potash mines in Alsace, which helps to give a true perspective of the part they are likely to play in the future production of the world's supply of potash, is contained in a short article in *La Nature* of October 2, p. 220. The value of these mines has undoubtedly been greatly exaggerated by the newspaper Press, but none the less, they are of great and real significance. As regards the scheme of nationalisation which has been frequently mooted,

it is pointed out that already 45 per cent. of the shares are held by Alsatians or Frenchmen, so that such a scheme is scarcely legitimate. Under the German *régime* the part reserved to the Alsatian mines by the *Kalisyndikat* of Stassfurt represented only 10 per cent. of the total sales, although a policy of free competition would have justified a far greater output. It is, however, probable that after the war arrangements will be made allotting to the Alsatian mines at least 25 per cent. of the total world's supply. The development of the Catalonian mines may modify this figure, but the development in this field promises to be slow.

WE have received a copy of the first issue of the Journal of the Association of Official Agricultural Chemists (Baltimore, U.S.A.: Williams and Wilkins Co.), of which the Syndics of the Cambridge University Press have undertaken the agency in the British Empire. The journal will be the official medium for the presentation of data and analyses in the domain of agricultural chemistry, and will include the proceedings of the association, reports of scientific research, and complete statements of the official methods. Until recently the work of the association has been included in special bulletins published by the Bureau of Chemistry of the U.S. Department for Agriculture; the publication in journal form will make this work available to a large public. The purpose of the association is to secure uniformity and accuracy in the methods, results, modes of statement of analysis of fertilisers, soils, foods, dairy products, medicinal plants, drugs, and other matters connected with agricultural industry. The journal, therefore, is of importance to the chemist, the agriculturist, and the manufacturer. It will be published quarterly, and each volume will consist of about 600 pages. The subscription price is 23*s*., post free. Subscriptions may be sent to Mr. C. F. Clay, Cambridge University Press.

EVERY engineer who, since the war began, has taken up the manufacture of war material has found himself hampered, and his output delayed, by the Woolwich regulations for inspection and gauging. The leading article in the *Engineer* for October 29 gives an interesting example of regulations which might be relaxed in the present circumstances. In the manufacture of steel bars for shells, the Government brand is put upon the material at every stage of its progress. The cast ingot is stamped, then the billet, and then the bar rolled from it. From the bar a dozen or more separate pieces, each to make a single shell, have to be cut. The brand is stamped upon the side of each piece before it is cut off. Rough turning removes it, and it has to be renewed on the base, then the base is cut away, and the brand has to be put on the side. In peace time this was splendid—the identity of every shell was preserved. At present there is no reason for keeping this close watch on every piece, and the final test stultifies the whole. Only one shell is drawn from a mixed batch of five hundred, and tested by firing from a gun. If it fails the whole mixed batch may be condemned. There are several other cases which might be quoted in which system appears to have run away with intelligence.

MESSRS. T. C. AND E. C. JACK (London and Edinburgh) have in preparation for their "Through the Eye" series:—"The Evolution of the Plant," by Dr. H. F. Wernham; "Greek Civilization," by Prof. J. S. Phillimore; "Bird Life," by W. P. Pycraft; "The Evolution of the Bird," by W. P. Pycraft; "Roman Civilization," by A. F. Giles.

OUR ASTRONOMICAL COLUMN.

VARIABILITY OF α ORIONIS.—In the current number of the *Observatory* Mr. F. W. Backhouse directs attention to the abnormally diminished brightness of this star. On October 14 it appears to have been 0·5 magnitude—one magnitude fainter than usual.

THE SOLAR CONSTANT.—Criticism of the extremely accordant determinations of the solar radiation made under the auspices of the Smithsonian Astrophysical Observatory has been based almost entirely on the amount of the correction for the effect of the terrestrial atmosphere. Prof. Very maintains that the Smithsonian observers underestimate this effect, consequently obtaining a value much too low. Although the Langley method has already been applied under a diversity of conditions—height above sea-level, atmospheric transparency, temperature, etc.—yielding satisfactorily harmonious results, yet unceasing efforts have been made to apply more and more severe tests by carrying out the measures under the least possible superincumbent air-mass. The most effective way in which this can be accomplished is by raising self-recording instruments to the greatest possible height in the atmosphere by means of free sounding balloons. An account of the most recent experiments of this kind is presented by Messrs. Abbott, Fowle, and Aldrich in a memoir (Smithsonian Misc. Coll., vol. lxv., No. 4, 1915), which forms an important contribution to the subject. Space only permits a hint at the ingenious instrumental devices embodied in the apparatus, the searching laboratory tests, and the manifold corrections involved in the reductions. The most successful day ascent was made on July 11, 1914, from Omaha. At a mean altitude of 22,000 metres (nearly fourteen miles) the three best records gave 1·76 Calories per sq. cm. per minute. Corrected to mean solar distance, etc., this becomes 1·84 Calories. The barometric record indicated a pressure of about 3 cm. of mercury (*i.e.* about 1/25 normal atmospheric pressure. Other pyrheliometric measures have been made at heights corresponding to pressures of 30 cm. (manned balloon, Dr. Peppler), 44 cm. (Mt. Whitney), and 62 cm. (Mt. Wilson). These records, with the maximum value observed by Dr. Kimball at Washington, when plotted lie quite close to a straight line. It is concluded that the Smithsonian value (1·93 Calories) for the constant of solar radiation outside the atmosphere is amply confirmed.

PROPER MOTIONS OF STARS IN THE REGION OF N.G.C. 6705.—Recently M. Comas Sola announced the discovery of a number of large proper motions in the region of this cluster (Messier 11) by stereoscopic examination of photographs. In view of the considerable interest recently aroused in this and allied methods of rapidly determining proper motions (see various notes in this column, also in the current number of the *Observatory*), it is important to note that Prof. E. E. Barnard (*Comptes rendus*, vol. clxi., p. 411) has examined the region of this cluster in the stereocomparator. Although the pair of plates were separated by an interval of twenty-two years (approxi-

mately seven times the interval between M. Sola's plates) no stars showing movement could be detected.

THE FUTURE OF THE PLANETS.—Under this title M. P. Puiseux contributes an essay to *Scientia* (October) dealing with some possible consequences of the explosion hypothesis due to Mr. R. T. A. Innes. The underlying idea is that sufficiently great pressure may be capable of inducing an explosive instability of the elementary atoms of matter resembling the transformations associated with radio-activity. If this is a fact of nature, then condensing stellar bodies become spontaneously explosive. It is supposed that the destruction of the planets will be brought about by a solar outburst of this character.

AMERICAN HYDROLOGY.[1]

THE issue by the United States Geological Survey of a further instalment of water supply papers directs attention to the continued activity of that department in prosecuting its researches into the national water resources available for industrial and agricultural purposes. The papers cover an extensive area of country and a diversity of subjects; and accordingly it will be convenient to deal with them seriatim.

(1) The eastern and southern coasts of the United States and the contiguous parts of Mexico and Central America, as far as the peninsula of Yucatan, constitute a broad, sub-level region, sloping gently seaward from the interior highlands. In the basin of the Mississippi, this plain, known as the Gulf Coastal Plain, extends inland for a distance of no fewer than 500 miles. This, however, is the maximum breadth. On the Atlantic coast and in Mexico it is much more restricted, reaching mountainous districts at no great distance from the sea. The plain is characterised generally by low relief and broad river valleys, and in Texas, with which region Mr. Deussen's report is specially concerned, it comprises a series of prairies and wolds, the latter term denoting a range of hills sloping gently on one side and descending abruptly on the other.

Being a hydrographical paper, the report is drawn up from the point of view of defining and classifying the available sources of water supply, and accordingly the stratigraphy of the various districts is described in relation to their water-producing powers. The geological systems represented are the Carboniferous, the Cretaceous, the Tertiary, and the Quaternary. The Carboniferous rocks are not exposed, nor have they been reached by any boring within the limits of the area under consideration, but their presence is inferred from an exposure further west, and by the evidence of drill-holes in the adjacent Cretaceous area. The Cretaceous rocks, which consist for the most part of chalk, limestone, and marl, are so deeply embedded as to render them impracticable as sources of supply, either by artesian wells or otherwise. The available water-bearing strata are, therefore, the sediments of the Tertiary and Quaternary series, comprising some dozen formations, of which may be noted the Dewitt (Miocene), 1250 to 1500 ft. thick, and the Wilcox (Eocene), 800 to 1150 ft. thick. The former consists of lacustrine and littoral deposits: cross-bedded, coarse, grey, semi-indurated, highly calcareous sandstones; and the latter of palustrine, marine, and littoral sands, clays, marl, and lignite. The waters from these sources are classified and analysed according to their locality and occurrence.

(2 and 3). The next two papers deal with the chemical side of water supply. They exhibit in tabular form the constituents of samples of water, taken from various sources in the United States, and submitted to chemical analysis, together with some useful notes as to the bearing of chemical composition on the suitability of such waters for specific purposes. Most of the waters are commonplace in character, but some are exceptional; for instance, the Devil's Inkpot in the Yellowstone Park is essentially a solution of ammonium sulphate, and the Shoal Creek springs in Missouri are impregnated with zinc to a remarkable degree.

The physiographical features of the State of Washington are described at some length in Mr. Van Winkle's report, and it is interesting to note that the Cascade Range of mountains, which crosses the State from north to south, divides it into two regions with very dissimilar climatic conditions, that on the western side characterised by an abundant rainfall, with cool summers and mild winters, and that on the eastern side by a moderate, and even scanty, rainfall, with hot summers and cold winters.

(4) The Deschutes River is a tributary of the Columbia River, entering the latter at a point about 135 miles above the town of Portland. It is stated that the river is unique in several respects among rivers of the United States. "Its natural flow is remarkably constant; its head waters afford reservoir sites sufficiently large and so distributed that the total flow of the river may be utilised both for irrigation and for power"—these features, combined with the suitability of the river basin for their practical application, justify the expectation that the Deschutes Valley will become a flourishing district of agricultural importance, enhanced by numerous installations of hydro-electric plant furnishing power, either locally or for transmission to distant distributing centres.

(5) The rugged region of western Montana includes a curious re-entrant of the Continental Divide, forming a basin, bounded on the north, east, and south sides, and on part of the west side, by mountain walls. This basin, the flat floor of which is a little more than a mile above sea-level, has a maximum length of twenty-two miles, a maximum width of ten miles, and an area of 130 square miles. It probably came into existence near the close of the Tertiary or at the beginning of the Quaternary period. It is noteworthy to-day as containing on its northern side the Butte mining district, the most important mining centre in the United States. Started in 1864, when placer gold was discovered in the locality, the settlement has grown to a town of more than 50,000 inhabitants. The effect of this invasion of human activity has been to change completely the natural aspect of the place. The mountain sides have been denuded of their trees and the valley floor of its luxurious vegetation by sulphurous fumes emitted in great clouds from the smelting works, and a scene of desolation and ugliness has supervened. Since 1912, however, conditions have somewhat improved. Most of the large smelters have been shut down or removed, and the citizens are endeavouring by the cultivation of lawns, gardens, and trees, to restore something of the original beauty of the valley. The climate is somewhat rigorous, the mean annual temperature being 42° F., and the lowest recorded temperature 29° F. below zero. The water supply of the district is plentiful; there is an average daily consumption of nine million gallons for 55,000

[1] (1) Geology and Underground Waters of the South-Eastern Part of the Texas Coastal Plain (Water Supply Paper No. 335). By Alexander Deussen. Pp. 365, with diagram and ix plates.

(2) Water Analyses from the Laboratory of the United States Geological Survey (Water Supply Paper No. 364). Tabulated by J. W. Clarke, Chief Chemist. Pp. 40.

(3) Quality of the Surface Waters of Washington (Water Supply Paper No. 339). By Walton Van Winkle. Pp. 105, with charts.

(4) Deschutes River, Oregon, and its Utilisation (Water Supply Paper No. 344). By F. F. Henshaw, John H. Lewis, and E. J. McCaustland. Pp. 200, with 28 plates and 8 diagrams.

(5) The Water Resources of Butte, Montana (Water Supply Paper No. 345-G). By O. E. Meinzer. Pp. 125, with map and photographs.

persons, or 165 gallons per head, which is a very liberal allowance compared with the customary consumption of large towns in this country. The figure is stated to include considerable quantities used by mines, railroads, and other industrial concerns, but even then it is greatly in excess of the standard prevailing in the United Kingdom. B. C.

ENGINEERING AT THE BRITISH ASSOCIATION.

SECTION G (engineering) had a very full programme, which necessitated carrying the meeting on until mid-day on Saturday, September 11. The papers were grouped as follows: after the president's address by Dr. Hele-Shaw on Wednesday, the morning was devoted to papers dealing with thermodynamics. The following morning was set apart for papers by local engineers, describing recent work in the various departments of municipal engineering (electric, gas, drainage, etc.); the papers read on Friday were all connected with electrical engineering, while Saturday morning was devoted to mechanical engineering.

Wednesday, September 8.—In his address the president insisted on the duty of the British Association to justify its existence by doing something tangible to help the Empire in the great industrial struggle which must ensue when the military struggle comes to an end. He advocated the formation of a committee, initially of the engineering section, not merely to offer its services to any Government department, but to consider and urge the initiation of those reforms which would strengthen our hands in the coming international industrial warfare. The first paper was by Profs. Asakawa and Petavel, describing a series of experiments on the efficiency and losses of a gas engine; a preliminary note on the subject was presented at the Birmingham meeting two years ago. The authors have determined the overall efficiency and the magnitude of the various losses with different mixtures and different compression ratios. The highest overall efficiency obtained was 27·4 per cent. The mechanical losses were determined by the rate of change of the kinetic energy of the rotating parts, as is very commonly done in testing electric motors.

Prof. W. M. Thornton gave two short papers of a theoretical and speculative nature, entitled "The Total Radiation from a Gaseous Explosion" and "The Change of the Specific Heat of Gases with Temperature." According to the author, the lost pressure or suppressed heat of a gaseous explosion can be explained mechanically by considering two combining atoms to act like colliding spheres. Their translational energy will generally be converted partly into vibrational and partly into rotational energy. Assuming that before the collision the translational and rotational energies of the atoms were equal, and that on collision the former is equally converted into rotational and vibrational, the latter, on which depends the radiation, will represent 25 per cent. of the total, which result the author claims to be in agreement with the observations of Hopkinson and David.

On Wednesday afternoon at the laboratories of the Manchester Steam Users' Association, Mr. C. E. Stromeyer explained and demonstrated a machine for determining the fatigue limits calorimetrically. In this machine the specimen, which is subjected to rapidly reversed torsion, tension, or bending stresses, is water-jacketed, and the temperature of the water passing through the jacket is measured on entering and on leaving. No difference is detected until the stress reaches the fatigue limit for the specimen under test, but as soon as this is passed, heating of the jacket water takes place. Hence the fatigue limit is determined by gradually increasing the stress and watching the two thermometers.

Mr. Stromeyer also gave a demonstration of the phenomenon of water hammer by means of gas-heated glass vessels and tubes.

Thursday, September 9.—Mr. de Courcey Meade, the corporation engineer, read a paper on the Manchester drainage scheme, and showed a number of lantern slides illustrating the special work in connection with the new sewers now under construction. He was followed by Mr. S. L. Pearce, the corporation electrical engineer, who outlined the growth of the electrical undertaking and then described the general outlines of the projected station at Barton on the Bridgewater Canal. When completed, this station, which at present exists on paper only, will be one of the largest in the country. It will transmit three-phase power at 33,000 volts to a number of substations. An interesting point is that the site is in close proximity to the corporation sewage works at Davyhulme, and it is proposed to use the purified effluent for condensing purposes, the canal authorities having refused permission to use the canal water. The increased temperature of the sewage effluent after passing through the condensers is advantageous in the further treatment before final discharge.

Prof. A. B. Field described the special research work which is being carried out in the mechanical engineering department of the Municipal School of Technology, which was afterwards visited by the members of the Section.

The corporation gas engineer, Mr. J. C. Newbigging, described the improvements recently introduced by the adoption of automatic vertical retorts; he also attacked the system of applying the profits from municipal gas undertakings to the relief of rates, instead of lowering the price of gas and thereby increasing its adoption for heating and power purposes. It need scarcely be said that this part of his paper did not go unchallenged in the discussion, dealing, as it does, with one of the thorniest problems of municipal politics.

A paper was read by Mr. E. C. Mills describing his producer for placing in front of an ordinary steam boiler. The gasification of the fuel is carried out in this external producer, while the combustion of the gas takes place inside the ordinary boiler flue. Slides were shown and actual test figures given for boilers which had been fitted with the apparatus.

Friday, September 10.—Mr. N. W. McLachlan showed experimentally the rapid heating of iron strips when magnetised by high-frequency currents obtained from an arc-generator. The variation of permeability with temperature and the points of recalescence could be traced in the variation of the current taken by the magnetising coil. The phenomena are complicated, however, by the skin effect, the depth of penetration varying with the temperature due to the changes in both resistance and permeability.

A self-adjusting commutating device was described by Prof. Miles Walker, in which each brush is divided into two, one in advance of the other, the two being lightly insulated from each other. Before combining, the current from one brush passes round the interpole winding, while that from the other passes through an equivalent resistance. If the commutation be perfect, the current density will be uniform over the whole brush contact surface, and each brush will collect half the total current; if, however, on account of saturation at heavy loads, the strength of the interpole be insufficient, the commutation will be so affected that a larger share of the total current will pass through the interpole winding, increasing

its flux, and thus compensating for the saturation. This device should prove especially useful in the case of rotary converters, where the commutation is often difficult; it will enable an increased output to be obtained from a machine of a given size.

A mathematical paper on "Electric Oscillations in Coupled Circuits" was read by Dr. Eccles and Mr. A. J. Makower. The special case considered was that in which three paths, each containing an inductance and a condenser, are connected in parallel. The formulæ obtained were confirmed by tests in two simple special cases, viz., two tuned circuits coupled either by a common condenser or a common inductance. In the discussion Prof. Howe showed that the two special cases dealt with experimentally could be calculated in a very simple manner by a suitable choice of initial conditions.

Prof. G. W. O. Howe then read a paper on "The Capacity of Aerials of the Umbrella Type," in which the method described by the author at the Sydney meeting last year was extended to aerials of this type. In the discussion Prof. Schuster pointed out that the small error due to the author's assumption of a uniformly distributed charge would be always in the same direction.

A note on "Earth Resistance" was read by Prof. E. W. Marchant, who suggested the use of the equivalent length of a column of the earthy material, which, with a cross-section equal to the surface of the buried conductor, would have the same resistance as the actual earth, as a criterion of the "earth." Prof. Howe showed that this "equivalent length" depended merely on the dimensions, and need not be determined experimentally, since such measurements depended on the uncertain specific resistance of the soil; it could be calculated in the same way as the capacity, if the conductors were surrounded by an insulating medium. Dr. Eccles pointed out the need for caution in applying the continuous or low frequency resistance to the case of a radio-telegraphic aerial.

Messrs. Lacey and Stubbings described some experiments to determine the effect of a third harmonic on the iron losses of a three-phase transformer, the harmonic being due to the saturation of the cores. With a triple harmonic of 48 per cent. the iron loss decreased 22·5 per cent. on opening the neutral wire; this would prevent any third harmonic in the current and would remove the sine-wave constraint from the magnetic flux, which would consequently reach a lower maximum value.

Prof. E. Wilson gave further information about a number of aluminium alloys, which have been exposed on the roof in London for many years, and on which he has reported on previous occasions.

Saturday, September 11.—Mr. T. H. Brigg described a new method of attaching horses to vehicles, the principle of which is that the shafts are forced upward by a spring, thus relieving the horse of a part of his own weight when travelling on an easy road. As soon as the road becomes more difficult, owing, say, to an up gradient, the increased pull on the traces overcomes the spring and exerts a downward force on the shafts, enabling the horse to obtain the necessary adhesion on the road.

The report of the committee on complex stress distribution was read by Prof. Coker. It consisted mainly of a comparison of the behaviour of a sample of mild steel when subjected to steady and alternating stresses respectively.

A paper on the strength of iron and steel struts was read by Mr. A. Robertson. It was a record of experiments on solid, free-ended, centrally-loaded struts made at Manchester University. The results confirmed Euler's formula, except for very short struts; the latter are discussed in detail in the paper.

Prof. C. Batho described a new method of determining the torsion stresses in framed structures and thin-walled prisms, especially useful in the case of cantilever bridges in which the suspended span is subjected to torsion, owing to unsymmetrical loading on the cantilever and anchor arms. The author showed the application of the method to a bridge of similar design to the new Quebec bridge.

Prof. Miles Walker described some experiments made to determine whether the acceleration of one mass exerts any force on a neighbouring mass, as it should do if the analogy between the electric current and the movement of matter be perfect. The results obtained were negative, although the apparatus combined great sensitiveness with the very rapid acceleration of large masses. Prof. Schuster expressed regret that a paper of such physical importance had not also been brought before Section A (Physics) of the Association.

This brought the proceedings of Section G to a close.

ANTHROPOLOGY AT THE BRITISH ASSOCIATION.

IN Section H (Anthropology) the proceedings showed little departure from the normal except perhaps in the small number of ethnographical papers, and in the character of the discussions which, on the whole, were a little less vigorous than usual, owing to the absence of many who, as a rule, may be counted upon to take part in the debates. The programme, however, showed a longer list of communications than might have been expected.

As in other sections, subjects of special interest at the moment were not neglected. Indeed, the principal item in the programme was a discussion which took place in joint session with Section E (Geography) on "Racial Distribution in the Balkans." This was opened by Prof. G. Elliot Smith, who, after a lucid exposition of the geographical, ethnological, and historical factors which have brought about the segregations and disunion of the Balkan peoples, went on to show that in spite of conflicting interests arising out of differences of history and creed, ethnological no less than geographical and economic considerations definitely linked together the Slovenes, Croats, and Serbs as one race, whose domain included not only Croatia (with Slavonia), Bosnia, Herzegovina, Montenegro, and most of Serbia as at present delimited, but also Dalmatia, nine-tenths of Istria (excepting Trieste), Carniola, and a strip of South Hungary. On ethnological grounds Bulgaria had a greater right than Serbia to the part of Macedonia now in occupation by the latter, and on racial grounds her claim to the Dobrudja was more justifiable than that of Rumania. Sir Arthur Evans exhibited a diagrammatic map illustrating the ethnic relations between the Adriatic, the Drave, and the Danube, the result of many years' observations in the area which is now occupied by the southern Slavs or Jugo-Slavs. Ethnological considerations supported the argument for a Jugo-Slav State. Italic preponderance was situated in the lower valley of the Isonzo, at Trieste, and in Istria. In Dalmatia, except in the town of Zara, the Italian element amounted to about 3 per cent. only of the population, the prevalence of Italian culture and the use of the language for commercial purposes giving a wrong impression. Sir Arthur then pointed out the value of the establishment of such a state in facilitating the completion of a railway, joining up

east and west along the main Roman road from Aquileia to Nissus, and running from Milan to Nish through Gradisca, Laibach, and Belgrade. The Hon. W. Pember Reeves, who was unable to attend the discussion, sent a communication in which, in dealing with the position of the Greeks, he urged that on historical and ethnological grounds their present northern boundary, including Epirus, corresponded closely to the ideal; while in Macedonia the line dividing the Bulgar-Slav portion from the Greek drawn by the Treaty of Bukarest represented the facts, especially as since the war of 1912–13 much migration had taken place on each side of the line. The claims of Greece to Bulgarian Thrace were justifiable on economic rather than ethnic grounds; on the other hand, the claim of Bulgaria to the eastern part of Macedonia was stronger than that of Serbia. In Monastir the existence of Vlach, Bulgarian, and Greek elements gave rise to a separate problem. It is scarcely necessary to emphasise the fact, upon which stress was laid by each speaker in turn, that political considerations had no part in the discussion.

Another matter of topical interest was the subject of a communication by Prof. Arthur Keith. In 1905 Prof. E. Manouvrier, of Paris, published a paper entitled "Une Application Anthropologique à l'Art Militaire: le Classement des Hommes et la Marche dans l'Infanterie," in which he advocated the classification of soldiers according to length of the lower limbs, rather than according to height, in order to minimise fatigue. This publication had not received attention in this country at the time of its publication, and a summary of its contents was now presented to the section at the request of the author. In the discussion which followed the hope was expressed that the suggestions might be put to a practical test.

A second discussion had for its subject "The Influence of Egyptian Civilisation on the World's Culture." It was opened by Prof. Elliot Smith and Mr. Perry. Their communications covered a wide field. They argued that towards the close of the new Empire a great many of the most distinctive practices of Egyptian civilisation, carried possibly in part by Phœnicians, suddenly appeared in the more distant parts of the coast lines of Africa, Europe, and Asia, and in course of time in Oceania and America. Mr. Perry relied in particular on the association of megalithic buildings and mine workings, or the situation of such monuments in or near regions noted for gold, precious stones, or pearl fisheries, as well as on similarities of technique in smelting or refining operations. In the discussion which followed, the opening speakers were subjected to some severe criticism. Sir Arthur Evans, while feeling that it was impossible to discuss adequately a subject of such vast extent, attacked their method of dealing with the evidence, and Prof. Petrie emphasised the necessity for greater precision in dating the facts with which they dealt. Sir Richard Temple pointed out certain difficulties in this connection in the treatment of the Indian evidence. Dr. Rivers, in supporting the openers, explained the reasons which had led him to modify his previous opposition to their position. The president pointed out that the difficulty of the length of time necessary for such a diffusion of culture was perhaps not so great as might be thought; a complete change had taken place in the diet of the native of South Africa since the discovery of America, when maize was introduced to the Old World.

Other communications, in addition to this discussion, also dealt with Egyptian archæology. Mr. Robert Mond made a valuable contribution to the method of recording archæological discoveries with an exhibit of a cardboard folding model of the Theban temple of Menna at Gurnah, on which photographs recorded all the scenes painted on the walls of the two chambers exactly in the position in which they were found. He proposes to survey all the temples and buildings of ancient Egypt in the same manner. Prof. Petrie described the magnificent find of twelfth-century jewelry of a princess, daughter of Senusert III., found by the British School of Archæology in Egypt at Lahun, which is in some respects finer than any yet known.

What was, however, felt to be one of the most important communications made to the section in the course of the meeting was a paper by Dr. E. A. Gardiner, "Fresh Light on the Origin of the Semitic Alphabet," which dealt with inscriptions of Pharaonic date in an unknown writing discovered by Prof. Petrie in Sinai in 1905. The inscriptions would appear to be alphabetic. A detailed analysis supported the conjecture that the system was related to, if it did not actually represent, the common parent of the Phœnician, Greek, and Sabæan alphabets. This Proto-Semitic alphabet apparently was hieroglyphic and acrophonic, *i.e.* the value of the letters was taken from the names of the things they represented.

Sir Arthur J. Evans, following Dr. Gardiner, dwelt upon the value for comparative purposes of the Cretan analogies for the origin of the alphabet, which were decisive against De Rougé's theory that the Semitic alphabet was derived from hieratic Egyptian forms representing similar sounds but having no reference to the actual meaning of the later name. To a certain extent the Minoan and Cretan forms appeared to belong to related systems. Dr. Gardiner's evidence tended to show that Semitic letters were derived from an indigenous source, and if the early forms went back to 1500 B.C. they could not have been introduced from Crete by Phœnicians. Nor did the ***aleph-beth*** theory of Gesenius require Egyptian influence, though it might have been present in both Semitic and Minoan as a formative element.

An interesting paper by Prof. R. S. Conway dealt with the religion and linguistics of early Italy. He described some votive offerings to the Venetic goddess Rehtia discovered on the site of a temple at Este, the ancient Atesta, about eighteen miles south of Padua. The offerings, which were of two classes, consisted of votive nails and wedges recalling Horace's description of *Dira Necessitas*, and bronze tablets divided into longitudinal bands, ten or twelve in number. The latter, the author suggested, might be connected with a game, and possibly were offerings of lucky players.

Two communications dealt with British archæology. The first, by Mr. J. P. Bushe-Fox, described the excavations at Uriconium in the year 1912–14. The finds included a large amount of pottery, evidence of industrial occupations, and a building of unique form. The second, by the Rev. Dr. Dukinfield Astley, on "Early Man in Norfolk," discussed the further evidence for the existence of Aurignacian man in East Anglia furnished by the results of excavations in Norfolk undertaken in 1914.

Among the papers dealing with social organisation and religion was an important communication by Dr. W. H. R. Rivers, on "Ceremonial and Descent in Ambrim," which adduced evidence to show that though at the present time the institutions of the island are patrilineal, in the older ceremonial, which is indigenous, the mother's brother comes into prominence. Consequently in this part of Melanesia it would appear that matrilineal institutions preceded the patrilineal.

Miss Margaret Murray, in her paper on "Royal Marriage and Matrilineal Descent," dealt with the

custom of sister marriage in the royal Egyptian and Semitic families, which, as she pointed out, were not regarded as unusual when recorded by native historians, and traced the customs to a more prolonged survival of inheritance in the female line in royal families. Dr. Nadine Ivanitzky's communication on "The System of Kinship among Primitive Races in connection with their Mode of Grouping" dealt with the manner in which economic and social factors act and react on the recognition of kinship in a group by determining the size of a group, its relation to other and competing groups, and the relation of the individuals within the group.

In physical anthropology, in addition to the paper by Prof. Keith, to which reference has already been made, Dr. Manson exhibited photographs and skiagraphs of members of a family showing hereditary syndactalism and polydactalism, and Dr. G. W. Hambleton discussed chest types in man in relation to disease. Prof. Guiffrida-Ruggeri's "Notes on the Neolithic Egyptians and Ethiopians." criticising the theories of Prof. Elliot Smith and others on the physical affinities of the early inhabitants of Egypt, and Prof. Elliot Smith's communication on "The Earliest Human Remains from India," owing to lack of time, were taken as read.

At the close of the proceedings, the section, at the invitation of the Ribchester Museum Committee, visited the Roman camp at Ribchester for the formal opening by Prof. F. J. Haverfield of the recently completed Museum of Roman Antiquities. Prof. Haverfield then delivered an address on the purpose of the small *castella* or forts, found scattered over all the north from Chester to Carlisle and from the vale of York to Tyneside, of which Ribchester is an example, as purely military units controlling the country from strategic points.

THE RELATION OF EDUCATION TO INDUSTRY.[1]

AT the last meeting of the British Association in Manchester, in 1887, the president, Sir Henry Roscoe, in his opening address, referred to national education with patriotic candour, in the following prophetic sentence:—"The country is beginning to see that if she is to maintain her own commercial and industrial supremacy the education of the people from top to bottom must be carried out on new lines. The question as to how this can be most safely and securely accomplished is one of transcendent national importance, and the statesman who solves this educational problem will earn the gratitude of generations yet to come."

A generation has passed since Sir Henry Roscoe uttered his prophecy, and still our national education is, though improved, far from being carried out on the principles and methods which will ensure our industrial supremacy. In other words, "the statesman" has not yet appeared!

By national education we mean, of course, the education of the whole people, not of a class only. From 1872 until as late as 1889 no attempt was made by Government to provide secondary and technical education in continuation of the elementary stage, and in consequence of this the progress made in scientific knowledge bearing on industry and commerce was withheld from our own people who most needed it, and left to other nations who were better qualified to reap the advantage. The results, it is well known, have been lamentable, for it so happened that it was during this very period that the most remarkable discoveries and development in science were revealed to the world, and their practical application demonstrated. During that period, and indeed long before, notably in Faraday's lifetime, England produced some of the most eminent men of science in the world, who opened out to us the immeasurable possibilities of adding to the material wealth and prosperity of our country by the adoption of their discoveries.

Only two countries, however, were ready to take practical advantage of these discoveries owing to their widespread facilities for education ranging through the elementary to secondary and technical schools up to scientific teaching in the universities. These countries were America and Germany.

Consequently the great discoveries relating to the utilisation of those subtle forces of electricity and magnetism achieved their first triumphs in these two countries, where the spirit of education had long before penetrated the lives of the people and prepared them to adopt and apply the new revelations of science to the common needs of human life.

These great movements stirred our Government at last to send out a Royal Commission to investigate the educational facilities in the secondary and technical schools of foreign countries. Oh, the pity of it! That a country which had enjoyed the greatest opportunities for the application of scientific discoveries and methods to industry through the undisturbed monopoly of engineering, chemical, and other industries extending over a full century, should have neglected the only means of retaining that position by the adoption, during the years of expanding wealth and prosperity, of a system of universal, free, and enlightened education open to every class throughout the land! The reports brought back from Europe by the Royal Commission, and one from America, written by myself after eight months' investigation, spread alarm throughout the United Kingdom and the British Empire. These reports were published in 1884. No action was taken by Parliament until 1889, when happily a Technical Instruction Act was passed, within two days of the close of the session, but almost by a fluke even then, owing to the efforts of a few desperate men on both sides of the House who believed that "through lack of knowledge the people perish."

Probably no Act of Parliament was ever seized upon with such avidity as this Technical Instruction Act, for, as the municipalities themselves were by the Act constituted the local administrative authorities, the large manufacturing districts, notably Manchester, Salford, and other parts of Lancashire, were especially eager in pressing for its adoption. The following year the "whisky and beer tax" was earmarked for the support of technical education, which resulted in numerous fine institutions being erected in many parts of the country. In 1902 secondary education was adopted permissively in a new Elementary Education Act, and though not adequate to meet the wants of the country, it was received with thanks for small mercies owing to the fact—which in some other countries would have been foreseen—that no system of thorough technical education can be carried out where secondary education is a missing link, so that for a time our national system of public elementary and technical education minus the secondary was more like "a rope of sand than a chain of welded links."

As a result of the passing of the Technical Instruction Act of 1889, the development of technical instruction was so rapid that in 1895 an Association of Technical Institutes was formed. A large number of new schools have been erected solely for the purpose of technical instruction, and are equal in equipment and staff to the average of those in the United States and

[1] Abridged from a paper read before the Section of Educational Science of the British Association at Manchester on September 11, by the Right Hon. Sir William Mather.

on the Continent. Such, for instance, are the schools of Manchester, Salford, Birmingham, Belfast, Sheffield, Bradford, Bristol, Edinburgh, Nottingham, London, and of these several take rank as technical universities where day students may graduate and recognised degrees may be obtained. In particular, the Imperial College of Science and Technology and the Manchester School of Technology are not surpassed by any similar institution in the world.

There are now eleven universities in England and Wales, including the ancient ones of Oxford, Cambridge, and Durham. The latter have conformed to the spirit of the age by adapting themselves to the requirements of science, while the more modern universities, though primarily established to meet the needs of industrial development, have taken ample care of the equally important subject of the arts.

A general survey of our present equipment for national education would, however, clearly show that we are still far below the standard our industries require if they are to compete successfully with those of other countries; therefore the most reactionary form of economy during the war would be the reduction of Government grants to education of any grade.

It would be noted also that no provision has yet been made to continue the education begun in the elementary schools through the period of adolescence —the impressionable period for good or evil—in the life of our young people who at fourteen years of age must begin to earn something towards their own cost of living. Each year something like 600,000 of these young people leave the elementary schools, forming a population of about two millions of young people, from fourteen to seventeen years of age, a prey to many evil influences, and comparatively few of them are accounted for in the attendances at the evening schools. Special provision for them has not yet been made, nor has any definite system of continuation schools for the manual worker yet been established; consequently the expenditure on public elementary education is largely wasted, and the mental, moral, and physical training of the children of the nation is suddenly arrested at fourteen years of age.

This link in the chain of education is so vitally important from the industrial point of view alone that it should be dealt with without delay by a special committee of industrial and educational experts; for after this war more than ever shall we need to use every advantage that the highest education can confer upon our people in order to utilise the ample material resources of all kinds which we possess, if we wish to maintain our place in the world of industry and commerce.

At this point I will venture to express a doubt as to the efficiency in administration of our national education system at the top, either for initiation or control. A Department of Education, with a Cabinet Minister as president, assisted by a permanent Secretary of Education and a vast number of inspectors and examiners and Civil Service clerks is, in my opinion, unsuitable for our country as well as extremely uneconomical. A bureaucratic spirit creeps into such a Department, without any one person being specially to blame, and such a spirit is the obstacle to enlightened progress.

The freedom and responsibilities of local administrative authorities, acting through competent directors of education and committees composed largely of the best and most enlightened in the community as coopted members, may be, and in fact are, frequently impaired or destroyed altogether.

The glaring inconsistency of the Board of Education, as at present constituted, lies in the political necessity of changing the president at every change of Government. The education of the people of the nation is a subject too sacred to be rendered liable to the whims and caprices of party politics.

A small salaried Council or Royal Commission of Education, appointed by Parliament from the best men the country possesses, regardless of party, each retiring at fixed periods, but eligible for reappointment, would suffice to represent the State in all respects, while ensuring the continuity of principles and methods of progressive education. The local authorities, under such conditions, would undertake large responsibilities with greater freedom, and higher educational efficiency would be assured throughout their respective areas of administration.

One's mind naturally associates the desire for true education chiefly with the industrial classes, and especially so in these times when, under the terrible stress and strain of a vast war, the real qualities of men and things are disclosed. It is obvious that a more thorough and enlightened system of education such as we have been considering would in the course of years render the relations between employer and employed totally free from the troubles we have had and must have from time to time under present conditions.

These disputes arise out of a sense of injury, real or imaginary, on the part of one side or the other, generally in connection with wages and hours of labour, or with questions of discipline and business management. Evidence is accumulating to prove that the relationship between employer and employed has hitherto, generally speaking, been based on false and glaringly unscientific principles. Trades unions and employers' federations exist more for organised defence and resistance than for peaceful progress, and it lies in the very nature of the present system of industrial management that this should be so. There is really as little cause for the two elements involved in industry, namely, capital and labour, to be divided, as for a household to be divided against itself. Employers and employed live, as it were, under one roof and for one purpose, the one being absolutely dependent on the other. They must rise, continue, or fall together. For want of a thorough understanding of this economic law, as old as the hills, yet never universally recognised, the path of industrial development has been strewn with the wreckage of lives, the waste of capital and energy, and at times with incalculable misery for thousands of women and children comparable only to a state of active warfare.

Where there is no true vision the people perish. Without the desire to learn, to know, to see and trust to a better way than that of recurring strife, the people deserve to perish. We must have visions in relation to industrial peace such as we visionaries hold in relation to international peace. After this Armageddon has been fought out and the victory won by those who fight for truth, justice, and right, against what appears to be the frantic force of evil doers, we must resolve to start again on a higher plane of industrial relationship, in the attainment of which education on the lines already indicated must necessarily be the leading factor.

No country in this world can so easily change the moral and mental growth of its children from the wrong direction to the right as Great Britain can. We possess absolute political freedom, the poorest of the poor amongst us casting as potent a vote under our self-governing constitution as the richest magnate in the land. With the political freedom and individual responsibility such as we enjoy, perfect discipline must ensue if we become educated scientifically to do the necessary thing in the right way, for the welfare of the country and of all who dwell therein.

If liberty and self-government by the people for the

people do not yield this result, it is obvious that we are not efficiently educated, that is, we are either not intelligent enough to know the right way from the wrong, or, knowing it, we do not care to follow it; which means that our moral nature, or higher self of spirit and conscience, has not become educated equally with our intellectual abilities.

The one outstanding menace, which imperils our very existence as an industrial nation, is the chronic separation of capital and labour, employers and employed, into opposing camps. Until the necessity of perfect unity of interest, of motive, and of purpose is recognised and established, we are building our industrial edifice on the sand, liable at a moment's notice to be shattered by the winds and storms of passionate discontent which sweep away what the best culture and skill may have erected. It is eminently unscientific to build on sand when rock is at hand. In building up our industries scientifically let us not forget that in its broadest sense science, as has been well said, "includes the elements of the theory of morals and those of political and social life." There is a science, therefore, which if applied to the elements of capital and labour will blend them into one organic, harmonious whole. The science of education will teach both labour and capital to look at the problems of industrial growth and success with cultured minds, instead of as now with minds only half made up—prone to err, to misjudge men and things, unable to see with an instructed sense of proportion, to differentiate between that which is true and that which is false, between right and wrong, in the complex questions affecting both. The science of management is as important as the science of mechanics. The latter shows the laws of right construction; the former, the way to peaceful control, to unity of purpose, and, above all, to equity in sharing results of the organic whole of capital and labour.

SMITHSONIAN EXPLORATIONS.

A FULLY-ILLUSTRATED pamphlet containing brief accounts of the more important explorations and field-work undertaken during 1914 by members of the staff of the Smithsonian Institution proper and of its branches, the National Museum, the Bureau of American Ethnology, and the Astrophysical Observatory, has recently been issued.

Dr. C. D. Walcott briefly outlines his summer's work in British Columbia and Montana, in continuation of his previous geological explorations in those regions. In the lower portion of Deep Creek Canyon, south-east of the city of Helena, a deposit of siliceous shale was examined, where some years ago Dr. Walcott discovered the remains of crab-like animals suggesting in form the fresh-water cray-fishes found in streams and ponds all over the world. "These fossils," says Dr. Walcott, "are the oldest animal remains now known, and the algal deposits, which occur at intervals for several thousand feet below the shales containing the crustaceans, are the oldest authentic vegetable remains. It is also most interesting that two types of bacteria have been found in a fossil state in the rock in association with the algal remains."

Continuing the excavations at the cave deposit near Cumberland, Maryland, Mr. J. W. Gidley, of the U.S. National Museum, has added to the already important collection from this region more than 400 specimens of fossil animals, deposited there in Pleistocene time. Among these was a practically complete skeleton of the large extinct peccary, measuring more than 4 ft. in length, a partial skull of a wolverine, and several skulls of extinct species of the black bear.

Mr. H. C. Raven, who has been collecting animals and birds for the Smithsonian Institution through the generosity of Mr. W. L. Abbott, gives interesting information respecting the inhabitants and the animals of Celebes, Malay Archipelago. Mammal life, according to Mr. Raven, is not nearly so plentiful in Celebes as in Borneo, where he was collecting during the previous season, but several peculiar animals have been captured by him, among them a specimen of Babirussa, a pig with peculiar erect tusks curved backward above the forehead.

An expedition under the joint auspices of the Smithsonian Institution and the Cuban Government spent two months on the coast of western Cuba for the purpose of making a complete biological survey of the waters of that region, and incidentally to obtain specimens for the exhibition series of the National Museum. The Smithsonian was represented by Mr. John B. Henderson, a Regent of the Institution, and Dr. Paul Bartsch, of the National Museum. Extensive dredging operations for securing marine specimens were carried on daily, and from several shore stations large numbers of specimens of land forms were taken. The expedition was quite successful, and a great quantity of valuable material is now in the hands of specialists of the National Museum for final report. Particularly good were the collections of marine organisms, especially the molluscs.

Early this year arrangements were made whereby Mr. Neil M. Judd, of the National Museum, was enabled to accept an invitation to participate in the archæological investigations in Guatemala, conducted by the American School of Archæology. Mr. Judd's special work was to superintend the making of plaster casts of several of the huge stone monuments that have made world-famous the ruins of the so-called "Temple Court," the religious centre of the sacred city of Quirigua. After this work, Mr. Judd paid a brief visit to the Mexican border to ascertain the anthropological possibilities among the Indian tribes of this region. But little survives, in the remnants of the Quiche, Cachiquel, and Tzutuhil tribes, to indicate the strength and magnificence of the Quiche empire which Pedro de Alvarado destroyed in 1523, at the beginning of his conquest of Guatemala. Although the natives of these interior valleys have always been considered treacherous, Mr. Judd experienced few difficulties, and his hurried journey seems to indicate that extended anthropological investigations in this region will be as easy as they are desirable.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Sir W. H. Solomon and Prof. G. H. Bryan have been elected to honorary fellowships at Peterhouse.

LEEDS.—The Senate, at a meeting held on November 3, passed a resolution expressing deep regret at the death of Sir Arthur Rücker. The Senate places on record its sense of obligation to Sir Arthur Rücker, who, with his colleagues forming the first staff of the Yorkshire College of Science, laid the foundations of its intellectual work and corporate life. It was their advice which encouraged the council of the Yorkshire College of Science so to widen the scope of its studies as to enable it to develop into a University embracing the disciplines of arts, science, medicine, and technology. Furthermore, the Senate records its grateful appreciation of the part which, in his last

years, Sir Arthur Rücker (as a member of the Advisory Committee on University Grants) took in framing the federated superannuation system for universities, now successfully adopted by all the university institutions of modern foundation in England and Wales.

OXFORD.—Dr. E. W. A. Walker, fellow of University College, has been appointed lecturer in pathology for five years from January 1, 1916.

Prof. H. L. Bowman, Waynflete professor of mineralogy, reports two valuable benefactions to his department. (1) Under the will of the late Sir Arthur Church has been bequeathed 100*l.* for the purchase of apparatus and specimens, together with the chemical and mineralogical apparatus and instruments in Sir Arthur's laboratory and his collection of mineral specimens (other than cut gem-stones). (2) A valuable collection of minerals made by the late Dr. Hugo Müller, containing some 2000 good specimens, has been presented by Mrs. Müller.

MR. A. R. HINKS, the Gresham lecturer on astronomy, will deliver four lectures on "Navigation and Maps" at Gresham College, Basinghall Street, E.C., on November 16, 17, 18, and 19. The time of the lectures is 6 p.m., and the admission is free.

IT is announced in the issue of *Science* for October 29 that the sum of about 80,000*l.* has been subscribed in the University of Michigan alumni campaign for 200,000*l.* with which to build and endow a home for the Michigan Union, as a memorial to Dr. James B. Angell, president emeritus; and that Delaware College, at Newark, has received a gift of 100,000*l.*, from a donor whose name is withheld, for the construction and maintenance of buildings.

THE Comité des Visites aux Blessés Belges has collected about three thousand volumes of French and Flemish works in order to provide Belgian wounded soldiers with literature in their own language. The committee now informs us that amongst the wounded there are many students and technical workmen who desire to follow up their studies, and for this purpose want books on science and engineering, chemistry, physical science, mathematics, mechanics, electricity, and other sciences; also commercial study books, technological works, etc. Any of our readers possessing surplus volumes of this nature should address them to Madame Carton de Wiart, at the library department of the committee, Sardinia House, Sardinia Street, Kingsway, London.

WE hope the appeal of the eminent physicians and surgeons on behalf of the London (Royal Free Hospital) School of Medicine for Women will meet with a generous and immediate response. For the enlargement of the school premises 30,000*l.* is required, and already 18,000*l.* has been received. This school (the only one in London at which women can receive a medical education) was rebuilt in 1900 in the expectation of an average annual entry of thirty-five students. During the last six years the annual entry has risen to sixty students. This session 110 new students have entered the school. Enlargement of the laboratories and lecture-rooms has become urgently necessary, and, an adjoining site having been secured, building has already begun. Already there is a grave shortage of men medical students, and in view of the valuable medical work women have done during the last forty years, it is earnestly to be hoped that women medical students will receive all the encouragement and help it is possible to provide.

THE calendar of the twenty-fourth session, that for 1915–16, of the University College, Reading, has been received. Notice is given in it that while the college will make every effort to adhere to the arrangements announced in the calendar, it may be necessary to modify them owing to the exceptional circumstances brought about by the war. The teaching work of the college is organised in three faculties—letters, science, and agriculture and horticulture, and in three departments—fine arts, music, and commerce and technical subjects. The faculty of agriculture and horticulture dates from 1913, and grew out of a department of agriculture formed in 1893. As a result of the Development Act of 1909, England has been divided into ten agricultural provinces, each consisting of a group of neighbouring counties and centred on a University Agricultural Department or an Agricultural College. The province which is centred upon University College, Reading, consists of the following counties:—Berkshire, Buckinghamshire, Dorset, Hampshire, the Isle of Wight, Middlesex, and Oxfordshire. It is the desire of University College, Reading, to assist in every possible way agriculturists who are resident in the Reading province, and, in cases where the county council contributes to the funds of the college, reductions are made in the fees charged to residents in those counties. As the result of an agreement with the British Dairy Farmers' Association, the British Dairy Institute was moved from Aylesbury to Reading in 1896. It is under the control of a joint committee of representatives of the association and of the college.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 4.—Sir William Crookes, president, in the chair.—Prof. W. E. **Dalby**: A diagram to facilitate the study of external ballistics. The paper describes a semigraphical method for solving problems relating to motion in a resisting medium, with particular application to the motion of a projectile after it has left the gun. It is shown how easily and rapidly problems of direct fire can be solved by the aid of the diagram, with an accuracy sufficient for most practical purposes, and probably to the same order of accuracy as that of the data from which the primitive curve is derived. For a given muzzle velocity, the range, the time of flight, the angle of elevation corresponding to the range, the angle of descent, found from the diagram, are respectively multiplied by the ballistic coefficient to get the actual values of these quantities. It is shown how easily Siacci's function can be integrated, and a curve showing the integral value of the function is added to the diagram. The diagram may be used for the solution of problems relating to high-angle fire just in the same way as the ballistic tables are used. The actual velocities are replaced by pseudo-velocities calculated in the way explained in the gunnery text-books, and then these pseudo-velocities are used with the diagram.—W. B. **Hardy**: An application of the principle of dynamical similitude to molecular physics. The principle of dynamical similitude is developed and applied to the case of the internal latent heat of evaporation. It is found that if temperature be proportional to the mean energy of progressive motion of the molecules, the internal latent heats of dynamically corresponding states should be given by the equation $LM = a\tau$, where L is the latent heat, M the gram-molecular weight, a a constant, and τ the temperature. This equation may be used either to identify corresponding temperatures or to test some assumption as to corresponding temperatures.—R. **Jones**: The motion of a stream of finite depth past a body. The method of considering the two-dimensional flow of an infinite fluid past a

body, as being constituted of a potential motion plus a circulation, is in the present paper applied to a stream of finite depth.—K. **Terazawa**: Deep-sea water waves caused by a local disturbance on or beneath the surface. Analytical investigations of sea-water waves produced by a local disturbance on the surface have been made by various writers. Prof. H. Lamb's paper (Proc. Lond. Math. Soc., (2) II., p. 371, 1904), on the subject is the most concise and comprehensive. The earlier part of this paper consists of an extension of his investigations, and discusses the cases where the initial prescribed displacement of the surface or impulse applied to it is of the form $A \cos m\theta/\varpi$, where ϖ is distance from origin, instead of being condensed in a point. The displacement of the surface is expressed as a power series of gt^2/ϖ, with zonal or associated harmonic functions as its coefficients. As to the sequence of events at the centre of the initial disturbance, there has hitherto been little examination. In this paper that point is discussed, the initial disturbance being assumed to be of the form $A/\sqrt{(b^2+\varpi^2)}$, and it is found that for this type there occur only a few rises and falls of the surface which cease in a short time. The latter part of the paper is devoted to the problem of the tidal wave caused in deep water by a submarine explosion having its source situated at a point or along a horizontal line, assuming this source to be placed so deep, or its force to be so gentle, that the surface of the water is not broken by the ejection of a water-column.—W. G. **Duffield**: The consumption of carbon in the electric arc. Experiments have been carried out to determine the amount of material lost by the poles of a direct-current carbon arc under different conditions of current and arc length. Before beginning the weighings the arc was burnt to shape; on this account consistent results have been obtained. For a given current the carbon consumption of both the anode and the kathode increases with the arc length until a constant value is reached. Using long arcs the consumption per coulomb decreases with increasing current; the ratio of anode to kathode consumption is about 1·5, increasing slightly with the current. The study of extremely short arcs leads to the following conclusions:—(1) The loss of an atom of carbon from the kathode of a very short carbon arc is accompanied by the transfer between the poles of a quantity of electricity equivalent to four electronic charges. (2) In long arcs the loss is due to this essential carbon disappearance plus a quantity due to combustion. No. (1) has been found to hold over a range of current strengths from 2 to 100 amperes.—Hon. R. J. **Strutt**: Observations on the fluorescence and resonance of sodium vapour. II.—J. G. **Leathem**: Some applications of conformal transformation to problems in hydrodynamics. Supplementary note.—L. **Isserlis**: The conditions under which the "probable errors" of frequency distributions have a real significance.—Prof. W. M. **Thornton**: The reaction between gas and pole in the electrical ignition of gaseous mixtures.—Lieut.-Col. A. G. **Hadcock**: The longitudinal strength of cylinders closed by screw plugs.—J. G. **Leathem**: Some applications of conformal transformation to problems in hydrodynamics.—A. B. **Wood**: Volatilisation of extremely thin radio-active deposits.—S. W. **Richardson**: Some experiments on the properties of dielectrics.—W. B. **Bottomley**: a bacterial test for plant-food accessories (*Auximones*).

Challenger Society, October 27.—Dr. E. J. Allen in the chair.—L. A. **Borradaile**: The mandibles and associated structures in prawns. The structures which surround the mouth of the common prawn were described, suggestions were made as to their functions, and problems presented by their morphology were discussed. Reasons were given for believing some at least of the appendages to be derived from limbs of a type which possessed four endites proximal to the endopodite, and one in the region of the ischiopodite. The rest of the endopodite might represent a sixth endite, such as that found on the thoracic limbs of Apus.

PARIS.

Academy of Sciences, November 2.—M. Ed. Perrier in the chair.—The President announced the death of Dr. C. J. Bouchard, member of the academy.—G. **Bigourdan**: The astronomical work of Fabri de Peiresc. An account of work done between 1604 and 1636.—Paul **Vuillemin**: The stamens in the Tropeolaceæ. The view put forward is the typical arrangement comprising three episepal stamens and six epipetal stamens. These do not form a cycle distinct from the corolla. The total number is reduced to eight in the normal flower, because the sixth epipetal stamen and the third episepal stamen form one.—J. **Haag**: The method of Otto.—P. **Zeeman**: Fizeau's experiments for different colours of the spectrum. If c is the velocity of liquid in a vacuum, n the refractive index of the fluid in motion, and v the velocity of the fluid relatively to the observer, Fresnel's formula for the resulting velocity is $v/n \pm (1-1/n^2)v$. Lorentz proposed to replace the coefficient of displacement,

$$(1-1/n^2), \text{ by } 1-1/n^2-\lambda/n.dn/d\lambda,$$

and the experiments described in the present paper were designed to compare these two coefficients. The arrangement due to Michelson and Morley (1889), slightly modified, was employed, and measurements were carried out with monochromatic light, in which λ varied from 4500 to 6870 Angström units. The experimental figures were in close accord with those calculated from the Lorentz formula,

$$1-1/n^2-\lambda/n.dn/d\lambda.$$

Full details are reserved for a later communication.—Marin **Molliard**: The experimental production of tubercles at the expense of the main stem in the potato. M. **Fleury**: The morphology of the massif of Porto-de-Moz (Portugal).—M. **Bergonié**: The electrical power absorbed by the electro-vibrator. The best conditions of use of this apparatus.—Louis **Roule**: The migrations of fishes of the family Mugilideæ.

BOOKS RECEIVED.

The Gases of the Atmosphere and History of their Discovery. By Sir W. Ramsay. Fourth edition. Pp. xiii+306. (London: Macmillan and Co., Ltd.) 6*s*. net.

Leeds University. Eleventh Report, 1913–14–15. Pp. 208. (Leeds.)

Abridged Scientific Publications from the Research Laboratory of the Eastman Kodak Co., 1913–14. Pp. 76. (Rochester, N.Y.: Eastman Kodak Co.)

State of Connecticut. State Geological and Natural History Survey. Bulletin No. 24: Triassic Life of the Connecticut Valley. By Prof. R. S. Lull. Pp. 285. (Hartford, Conn.)

Bartholomew's War Map of Italy and the Balkan States. New edition. (Edinburgh: J. Bartholomew and Co.) 1*s*. net.

A Historical Atlas of Modern Europe from 1789 to 1914, with Historical and Explanatory Text. By C. G. Robertson and J. G. Bartholomew. Pp. 24+36 maps. (London: Oxford University Press.) 3*s*. 6*d*. net.

Annals of the Solar Physics Observatory, Cambridge. Vol. iii., part i.: The Solar Rotation in June, 1911, from Spectrographic Observations made

with the McClean Solar Instruments. By J. B. Hubrecht. Pp. 77. (Cambridge: At the University Press.) 9s. net.

Rhizopod Protozoa, the Cause of Cancer and other Diseases, being part iv. of "Protozoa and Disease." By J. J. Clarke. Pp. xiv+187. (London: Baillière, Tindall, and Cox.) 7s. 6d. net.

The Romance of the Spanish Main. By N. J. Davidson. Pp. 313. (London: Seeley, Service and Co., Ltd.) 5s.

Evolution. By J. A. S. Watson. ("Through the Eye" series.) Pp. vii+157. (London and Edinburgh: T. C. and E. C. Jack.) 5s. net.

The Cures of the Diseased in Forraine Attempts of the English Nation, London, 1598. Reproduced in Facsimile, with Introduction and Notes by C. Singer. Unpaged. (Oxford: At the Clarendon Press.) 1s. 6d. net.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 11.

ROYAL SOCIETY, at 4.30.—Effects of Function Activity in Striated Muscle and the Submaxillary Gland: J. Barcroft and T. Kato.—Analyses of Agricultural Yield. Part II. The Sowing-date Experiment with Egyptian Cotton, 1913: W. L. Balls and F. S. Holton.—On Williamsoniella, a New Type of Bennettitalean Flower: H. H. Thomas.—Studies on *a priori* Pathometry. Part I.: Sir Ronald Ross.—The Spread of the Excitatory Process in the Vertebrate Heart. Part I. The Toad's Ventricle. Part II. The Tortoise Ventricle. Part III. The Dog's Ventricle. Part IV. The Human Ventricle. Part V. The Bird's Heart: T. Lewis.

MATHEMATICAL SOCIETY, at 5.30.—(1) The Second Theorem of Consistency for Summable Series; (2) Weierstrass's Non-differential Function: G. H. Hardy.—The Kinetic Theory of the Motion of Ions in Gases: F. B. Pidduck.—Some Singularities of Surfaces and their Differential Geometry: H. W. Turnbull.—Periodic Solutions of the Problem of Three Bodies in Three Dimensions: J. W. Campbell.—Functions of Positive Type and Related Topics in General Analysis: C. R. Dines.—Surfaces Characterised by Certain Special Properties of their Directrix Congruences: C. H. Yeaton.

FRIDAY, NOVEMBER 12.

ROYAL ASTRONOMICAL SOCIETY, at 5.—(1) Inequalities in the Period of the Eclipsing Variable R.T. Persei; (2) Inequalities in the Period of the Eclipsing Variable Z Draconis: R. S. Dugan.—The Rotation of the Earth: H. Glauert.—Solar Eclipse of 1916 December 24: Rev. W. F. Rigge.—Observations of Comet 1915 *a* (Mellish) at Utrecht Observatory: J. van der Bilt.—Occultation Results, 1914: M. E. J. Gheury and Nora E. Robertson.—Conjunctions of Stars with Moon Recorded by Ptolemy: J. K. Fotheringham.—Micrometrical Measures of 400 Double Stars: W. S. Franks.—Note on Nebulæ and Clusters shown on Franklin-Adams Plates: H. Knox Shaw.—Comparison of the Bordeaux, Washington, and Algiers Catalogues: R. J. Pocock.—(1) Measures of Small Stars in the Dumb-bell Nebula; (2) Positions of Faint comparison Stars near R Cygni: E. E. Barnard.—Sextant Observations of Comet 1915 *a* (Mellish): R. Craven.—Comparison of Hansen's Tables as Modified by Newcomb, and Delaunay's new Tables with Observations made at Greenwich in 1914: Royal Observatory, Greenwich.—Positions of Comet 1915 *a* (Mellish): E. H. Beattie.—Magnitude Scales of the Astrographic Catalogue, 8th Note: the Cape Magnitudes for $-42°$: H. H. Turner.—The Fixed Binaries: E. H. Beattie.—New Form of Mechanical Drive for Equatorials: Scriven Bolton.—Illumination of the Field of a Photographic Objective; H. C. Lord.—On the Shape of the Earth; suggested by Mr. H. Jeffreys' Paper: "Certain Hypotheses as to the Struction of the Earth and the Moon": A. R. Hinks.—Viscosity in Relation of the Earth's Free Precession: Sir J. Larmor.—Provisional Orbit Elements of Comet 1915 *a* (Mellish): C. J. Merfield.—Magnetic Disturbances, 1904–1913, as Recorded at the Royal Observatory, Greenwich, and their Association with the Solar Rotation: E. W. Maunder.—The Dynamics of a Stellar System. III. Oblate and other Distributions: A. S. Eddington.—The Efficiency of Sun-spots in Relation to Terrestrial Magnetic Disturbances: Rev. A. L. Cortie.—Convection Currents in High Regions of the Solar Atmosphere: F. Henroteau.

PHYSICAL SOCIETY, at 5.—The Effect of Electric Oscillations on the Magnetic Properties of Iron, Investigated by the Campograph: Prof. P. R. Coursey.—(1) A Hydraulic Analogy of a Wheatstone Bridge; (2) A Lecture Table Method of Obtaining Recalescence Curves; (3) The Leeds and Northrup Recorder: R. S. Whipple.

MONDAY, NOVEMBER 15.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Presidential Address: The Southern Frontiers of Austria: Douglas W. Freshfield.

MEDICAL SOCIETY, at 8.30.—*Discussion*: Gunshot Wounds of the Head: Introduced by P. Sargent and Dr. G. Holmes.

TUESDAY, NOVEMBER 16.

INSTITUTION OF CIVIL ENGINEERS, at 5.30.—The Punjab Triple Canal System: Sir John Benton.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 5.—The Welsh People: An Anthropological Analysis: Prof. H. J. Fleure and Dr. T. C. James.

INSTITUTION OF PETROLEUM TECHNOLOGISTS, at 8.—The Viscosity of Oil in Relation to its Rate of Flow through Pipes: Dr. R. T. Glazebrook, W. F. Higgins, and J. R. Pannell.

WEDNESDAY, NOVEMBER 17.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—The Mounting and Illumination of Barometers and the Accuracy obtainable in the Readings: J. S. Dines.—On the Seasonal Variability of Rainfall over the British Isles: N. A. Comissopulos.

GEOLOGICAL SOCIETY, at 5.30.—Geological Observations in the Northern Half of the East African Protectorate: J. Parkinson.

ENTOMOLOGICAL SOCIETY, at 8.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Foraminifera of the Shore Sands, and Shallow Water Zone of the South Coast of Cornwall: E. Heron-Allen and A. Earland.

THURSDAY, NOVEMBER 18.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: The Theory of the Capillary Tube: Lord Rayleigh.—The Effect of the Form of the Transverse Section on the Resistance to the Motion of an Elongated Body Parallel to its Length through a Fluid whose Viscosity is not Negligible: Prof. C. H. Lees.—(1) A Method of Estimating Distances at Sea in Fog or Thick Weather; (2) A Method of Avoiding Collision at Sea: Prof. J. Joly.—The Flow of Electricity through Dielectrics: S. W. Richardson.—The Kinetic Theory of Gaseous Viscosity and Thermal Conduction, and the Law of Distribution of Molecular Velocities in the Disturbed State: S. Chapman.

ROYAL GEOGRAPHICAL SOCIETY, at 5.—Distribution of Nationalities of Hungary: B. C. Wallis.

LINNEAN SOCIETY, at 5.—Hollow-shafted Feathers: W. M. Webb.—Photographic Studies of Welsh Vegetation: Dr. E. J. Salisbury.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Inaugural Address by the President, C. P. Sparks.

FRIDAY, NOVEMBER 19.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—The Chemical and Mechanical Relations of Iron, Molybdenum, and Carbon: Prof. J. O. Arnold and Prof A. A. Read.—The Cause and Effect of "Ghost Lines" in Large Steel Forgings: Prof. J. O. Arnold.

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THURSDAY, NOVEMBER 18, 1915.

SCIENCE FOR ALL.

THE little attention given to science in education and in the public mind has been the theme of many essays and addresses. In both cases science is usually regarded as suitable for study by a select few only, and not as an essential part of all modern life and thought. Latin and Greek, history, and the literature of other times receive almost as much consideration now as they did before scientific discovery changed the whole aspect and outlook of life; and the mass of the people, as well as most of their leaders, are in their training deprived of light which should illumine the minds of all.

We do not for a moment suggest that the end of all education should be preparation for scientific careers; neither do we ask that men of letters, statesmen, and administrative officers of departments of State should all be scientific experts. To make such claims would be unreasonable, though not more so than the accepted principle that familiarity with classical languages and literatures is a necessary qualification for such positions, and that the first place must be given to these subjects even if matters more closely related to modern conditions of existence in war or in peace have to be neglected. Our claim is that everyone—from elementary-school pupil to college don—should be made acquainted with appropriate outlines of scientific work and thought. We want science to be a part of every general education, and we urge that the times demand this recognition of its influence and potentialities. When this modernisation has been accomplished, facilities for scientific work will be increased a hundredfold, and the public will not be deceived by sensational announcements in the daily Press, or tolerate official indifference to the growth of natural knowledge.

It may be doubted whether the methods now followed in the teaching of scientific subjects in schools are as effective in creating or fostering interest in science as those formerly adopted. Twenty years ago or so, much more attention was given to the attractive side of science than is now the case. Pupils were shown interesting experiments or were encouraged to read about remarkable facts and phenomena in Nature; and if they took a practical course they were able to cover a fairly wide field. In physics, for example, a student could learn something about the whole elementary range—mechanics, heat, sound, light, electricity, and magnetism; in chemistry he would see many striking changes and effects, such as impress themselves upon the youthful mind; in natural science he would be told many wonderful facts about birds and beasts and other objects—animate and inanimate—in the world of Nature.

No comprehensive survey of this kind is possible under existing conditions of science teaching in schools. In physics few students get beyond a course of work in mechanics and heat, and they leave school without receiving any instruction in other branches of the subject; their practical chemistry is frequently limited to manipulations and a study of air and water; and work in Nature-study means mainly the observation of a few facts of plant physiology or of animal development and habits.

Personal observation, intelligent inquiry, quantitative test, are, of course, essential factors of scientific method, but we believe that to insist upon all school science being controlled by them is a mistake. The limited amount of time that is given to science in schools renders true research methods impracticable; and pupils in general can scarcely be expected themselves to possess the motive and the purpose that lead to scientific investigation. Every teacher knows that only rarely is a pupil capable of initiating an experiment or of arriving at a statement of law or principle from results obtained by practical work. Little justification can be found, therefore, for the concentrated attention given to a few subjects, with the view of imparting knowledge of experimental methods, when such a course means that the wonders of the fields beyond are kept outside the range of vision.

School science as at present taught, and as defined by examination syllabuses, seems to proceed on the assumption that every pupil is to become a skilful experimenter, or an original investigator, in the realms of Nature. Courses of laboratory work designed with this intention may not unfairly be compared with the test-tubing of former times, which aimed at making every boy an analytical chemist. The practical work now done is certainly more valuable as a means of scientific training than it used to be, but it may be doubted whether by such exercises science can claim a prominent place in the curriculum. Modern life requires that the elements of scientific method and knowledge should form part of every educational course. School work should not be concerned in training experts in science, any more than specialists in classics, but with imparting the rudiments of a liberal education to all pupils, so as to awaken

interest which will continue when schooldays are over.

That is the standard—abiding interest—by which successful teaching may be judged; and we are disposed to think that the descriptive and qualitative school science of a generation or two ago was better adapted to promote such continued attention than is the quantitative work in the narrow fields mapped out for instruction to-day. In their anxiety to impress pupils with a sense of scientific accuracy and cautious conclusion, advocates of the methods now in vogue have forgotten that it is even more important to present a view of science which shall be human as well as precise. To the general neglect of this aspect of scientific study, which appeals to all, must be ascribed the fact that science has lost much of its former popularity, and has become a task in which only a favoured few can hope to excel.

It is a thousand pities that science should be considered to be merely a burden of material fact and precise principle which needs a special type of mind to bear it. We want much more of the spirit, and less of the valley of dry bones, if science is to be made of living interest, either during school life or afterwards. We want everyone to know something of the lives and work of such men as Galileo and Newton, Pasteur and Lister, Darwin and Mendel, and many other pioneers of science. The way to inspire wide interest in the achievements of men like these is not by the laboratory teaching of a few, but by suitable descriptive literature for all. In books intended for general reading, information should be made subordinate to inspiration, and broad outlines of great discoveries or fruitful ideas should be presented instead of tedious detail. It should be shown that self-sacrifice, persistence, courage, duty, accuracy, love of truth, and like attributes of greatness, may all be abundantly exemplified from the careers of men of science.

The achievements of science represent increase of knowledge, not alone for the man who makes it, not alone also for the nation or country to which he belongs, but for the whole human race. The conquests of science do not mean the aggrandisement of one country or people at the expense of another, but gifts to all who will receive them. The only domain which it is desired to penetrate is that of ignorance; and the fight is against the physical and mental death which is its heritage. Ignorance made plague the terror of Europe in the Middle Ages; science has proved that the disease is due to a bacillus which is conveyed by fleas from rat to rat, and from rats suffering from the disease to mankind. Ignorance ascribed malaria to a miasma or bad air arising from marshy places; science has shown it to be carried from one human being to another by a certain species of mosquito. Ignorance of the cause of yellow fever made the regions around the Caribbean Sea the White Man's Grave, where the risk of death for the visitor was greater than in a battle; knowledge that the disease is communicated from an infected to a healthy person by the bite of a particular mosquito has been the means of converting the same places into tropical health resorts. One practical result of the discovery of the cause of yellow fever was that it made possible the construction of the Panama Canal. It was not a hostile army or political difficulties that obstructed the work commenced by de Lesseps, not mountain chain or desert waste, but an insect which raised a barrier of disease and death between endeavour and accomplishment.

We have in uplifting stories of this kind—and there are many others—plenty of themes for epics which, rightly used, will stimulate interest in science, in both old and young. When a place for such literature is found in every educational course, the number of people who will follow scientific work with sympathetic minds will be greatly increased. At present school science means mostly determinations of specific heats or chemical equivalents, and similar exercises, while the deeds and thoughts which give living interest to material studies are neglected altogether. We do not ask that science students only should be given much broader views of natural knowledge than can be acquired through laboratory manuals and class text-books, but that the historical and literary studies in all schools and colleges should include works in which great scientific achievements and generalisations are expounded. We are confident that such subjects can be made attractive to almost every mind, and that the want of general and intelligent interest in them is due largely to the neglect of descriptive scientific literature in all stages of instruction.

It is unfortunately true that men of science themselves are often interested only in their own special field of work, and pay little attention to what is being done in other directions. These are the days of specialised study, and though the high powers used for the eyepieces enable new details to be discerned, the field of view is greatly restricted in extent, and the sense of true proportion is lost. Specialisation is essential for advance, but when it also means indifference to external movements and influences, it does not repre-

sent the highest type of intellectual activity. We cannot urge with any force the desirability of bringing the laity to appreciate the outstanding points of scientific work if specialists in particular sections of such work manifest no interest in the results of investigations by their colleagues in other departments, or will not trouble to make themselves understood outside their own esoteric circle. Papers read before scientific societies are now so highly specialised that only occasionally can they be followed with intelligent interest by the whole of the fellows present at a meeting, and usually not more than two or three people are capable of criticising them. As this is the case in circles where at any rate the general language of science is understood, it is not strange that people who have not had a scientific education should believe that scientific description must be beyond their comprehension.

This belief is probably responsible for the fact that there is little demand for popular works on science and few large audiences for scientific lecturers. We can say without fear of substantial contradiction that in such an inspiring subject, for example, as astronomy, attempts at popularisation by books or lectures have less chance of success than they had fifty or a hundred years ago. We are well aware that there are a few individual exceptions to this generalisation, but the statement can be fully justified as a whole, not only as regards astronomy, but also by the experiences of most authors and lecturers in other branches of science. There has been a vast increase in periodical publications and general literature, but the increase in scientific literature has been in the direction of text-books and treatises rather than in popular works, to which little encouragement is given, either by men of science or the public.

We should be sorry to suggest that scientific work is necessarily associated with poor literary style; indeed, we are sure that the literary compositions of men of science compare very favourably with those of other workers who are not purely men of letters. It may be doubted, however, whether sufficient encouragement is given to young scientific men to cultivate the power of clear expression, or whether sufficient appreciation is shown of efforts at making science intelligible to the people. An author like Mr. H. G. Wells, who creates wide interest in scientific work, is doing far better service to science than he would if he had concentrated his attention upon the minute biological structures of his early days as student and teacher. It would be greatly to the advantage of science if there were many more writers possessing like scientific knowledge with brilliant imagination and convincing pen.

Science can only secure its rightful position in a democratic State when its work and worth are widely known and understood. The makers of new knowledge can be trusted to continue to add to the stores already accumulated, but they should remember also that popular interest means increased support for their work and greater use of the results. It is rarely that great capacity for original investigation is combined with the gift of attractive exposition, and more rare to find both qualities being used for the popularisation of science, as, for example, in Sir Ray Lankester's series of masterly notes and essays, three volumes of which have now been published. We believe the influence of such literary work upon the public mind is much greater than is generally understood, and we should like to see many equally attractive efforts of a similar kind in other scientific fields than those with which Sir Ray Lankester is most intimately acquainted.

The war has made people think of more serious things than those which had their attention a year or two ago, and there are signs that a more satisfying literature will be required than the light pabulum which has hitherto served. What could be better adapted to provide for the coming need than the rich materials of science when attractively displayed? It is the privilege of scientific workers to have garnered these stores; and it is equally their duty to see that the nation does not perish for want of the stimulating food which they can furnish. If science does not come into its kingdom in the immediate future, it should not be for want of endeavour to enlighten the mind of the public and create intellectual interest in its aims, but because the people are content to be ignorant of the truths learned in the innermost courts of the temple of Nature, and to be without the power which such knowledge can give them.

ORIGIN OF THE INDIAN CASTE SYSTEM.

The People of India. By Sir H. Risley. Second edition, edited by W. Crooke. Pp. xxxii + 472 + xxxv plates. (Calcutta and Simla: Thacker, Spink and Co.; London: W. Thacker and Co., 1915.) Price 21*s.* net.

THIS memorial edition of the late Sir H. Risley's standard work on Indian anthropology has fortunately been entrusted to the competent hands of Mr. W. Crooke. As no notes were left by the author for a new edition, the editor has reproduced the text generally as it stood in the first, which had quickly run out of

print; but Mr. Crooke has introduced many improvements. He has brought the statistics up to date, secured greater uniformity in spelling the vernacular names, added numerous footnotes, correcting statements and theories which have been proved to be erroneous or doubtful, and given an appreciative memoir of the author's pioneer anthropological work in India.

Important additions also have been made to the illustrations, which previously had been restricted to rather inferior reproductions of several of the beautiful photographs by Sir B. Simpson in Dalton's "Descriptive Ethnology of Bengal"—a work also now difficult to procure. The inclusion of some excellent photographs for other parts of India makes the series now more representative.

The main thesis of the book is the contentious one on the origin of the caste-system. There is no doubt that Risley exaggerated the antiquity of the present social grouping of the people in his belief that the supposed fixity of caste dated to a remotely early period, and had thus presumably preserved in India a remarkable purity in physical type. Mr. Crooke, however, shows that caste in its modern rigid form in India is relatively recent. The older custom, as seen in the Vedas and Epics, recognised the possibility of a member of the "warrior" class (*Kshatriya*) becoming a Brahman, or *vice versâ*. A second wife could be taken from any lower class, and such laxities in practice still prevail in the more outlying districts of the Himalayas and the Panjab amongst groups of relatively pure Aryan stock. In many areas in India it is shown that the existing tribes and castes represent mixtures of various races which had amalgamated within a comparatively late historic period.

On the disputed origin of the warlike castes of Upper India, the long-headed Rajputs, Jats, and others, Risley opposed the present fashionable theory which would bring these people from Central Asia. This he did on the old idea that the people of Central Asia were of a uniform brachycephalic type, which is now known to be certainly not the case. Mr. Crooke seems to approve the recent theory of Smith and others that the Gurjari and the other associated "Rajput" tribes of Upper India are largely, if not wholly, formed by the Hun invaders of the early centuries of the Christian era. Yet it is precisely in these and associated tribes that Risley finds his purest Aryan type!

Regarding the Marathas, the dominant tribe of Western India, Risley's suggestion, based upon some reputed, but not clearly established, brachycephalism in the Deccan, is that they originated in bodies of Scythians driven down from the Western Panjab and intermarrying with the Dravidians. Mr. Crooke points out that there is no historical nor even traditional evidence of any Scythian migration into the Deccan; whereas the Marathas are closely connected with a mixed race of cultivators extending over a wide area, from the Deccan to the Ganges Valley, and known as Kumbi or Kurmi. These and other results of later research would no doubt have been considered by the author himself had he lived.

To many workers the most important part of the book will perhaps be the anthropometric tables, consisting of seriations of the several physical types. These and the maps of caste-distribution are of permanent value. The large collection of caste-proverbs will be found curious and interesting to students of folk-lore.

The only mistake we have noticed in the references is that the article cited at page 2 from the "Journal, Royal Asiatic Society" should be for the year 1898, and not 1908.

L. A. WADDELL.

PHILOSOPHY OF SCIENCE.

(1) *Proceedings of the Aristotelian Society.* New series, vol. xv., containing the papers read before the Society during the Thirty-sixth Session, 1914–1915. Pp. 441. (London: Williams and Norgate, 1915.) Price 10*s.* 6*d.* net.

(2) *Selections from the Scottish Philosophy of Common Sense.* Edited by G. A. Johnston. Pp. vii+267. (Chicago and London: The Open Court Co., 1915.) Price 3*s.* 6*d.* net.

(1) OF the twelve papers and symposia collected in the Proceedings of the Aristotelian Society for the last session, four are direct criticisms of positions taken up by Mr. Bertrand Russell. In the inaugural address on "Science and Philosophy," Dr. Bosanquet criticises the view, maintained in Mr. Russell's recent Lowell Lectures, that philosophy, as the science which aims at stating all that can be known *a priori* about all possible worlds, should be ethically neutral, and that it is just because philosophy in the past has been biased by the desire for agreeable conclusions that philosophy has not made the same progress as the physical sciences. Dr. Bosanquet holds that this view implies an antecedent limitation of philosophy, and involves the confusion that because the interest of philosophy is purely theoretical, therefore its subject-matter is itself theory and its objects.

In a paper of extraordinary acuteness, Mr. C. D. Broad deals with Mr. Russell's attempt in

the same lectures to work out a phenomenalist philosophy of science. All physical science starts with directly observable sense-data, and physical laws can only be verified by finding that predictions as to the nature of sense-data based on these laws are actually borne out by direct observation. Accordingly Russell argues that it is theoretically possible, on the principle of Ockham's razor, to state all that is implied by the laws of physics in terms of sense-data alone.

Mr. Broad urges (*a*) that Russell's attempt at phenomenalism is not nearly so "economical" as he supposes. Whereas the ordinary view assumes imperceptible physical objects, the qualities and existence of which are inferred from sense-data, Russell gives us an immensely greater number of imperceptible sense-data, likewise inferred from the sense-data of which we are immediately aware, which are of the same logical kind as physical objects on the ordinary view. The difference in simplicity is not, then, in Russell's favour. (*b*) Russell's theory is very far from expressing the laws of physics in terms of sense-data. *E.g.*, take the statement that iron expands when heated. It is not enough to say that if a certain group of grey visual sense-data is accompanied by a certain group of hot tactual sense-data, then as the latter get hotter the former get larger. Usually the increase in length can only be detected by a micrometer gauge. But the micrometer must in turn be analysed into visual and tactual sense-data, and further the facts which on the ordinary physical theory we call the proper use of the micrometer must also be resolved into muscular and other sense-data. Exact statement of a physical law in purely phenomenal terms is, therefore, intolerably complicated. What physical science and common sense do is to analyse such complicated but directly verifiable statements into two laws more general but not separately verifiable, one as to changes outside the body, "Iron expands when heated," and the other stating the action of external objects upon the body which results in the awareness of sense-data and of changes in them.

In a paper entitled "Complexity and Synthesis" Mrs. Adrian Stephen compares the views of Russell and Bergson as to the nature of sense-data. Prof. Stout's paper, "Mr. Russell's Theory of Judgment," is a criticism of the treatment of judgment in Russell's "Problems of Philosophy." Russell there maintains that the fact of error forces us to the conclusion that judgment is not a dual, but a multiple relation, *i.e.*, one which, like "between," involves more than two terms. Othello's judgment that Desdemona loves Cassio is not a relation joining Othello's mind to the one objective complex, Desdemona's love of Cassio, because the falsity of Othello's judgment means that there is no such thing as this complex: the belief unites Othello's mind and the three objects Desdemona and loving and Cassio. Stout urges that on this view there is nothing before the mind to correspond to actual fact. The mind in judgment cannot be aware of the judgment complex, because that complex includes the act of judgment. And the objects of judgment have, apart from the relation of judgment, no order which can be compared with the factual order which is to determine their truth or falsity.

In his paper, "Conflicting Social Obligations," Mr. G. D. H. Cole attempts to provide a philosophical basis for the social and economic doctrine he has put forward in his recent works, "The World of Labour" and "Labour in War Time," and in a number of articles in the *New Age* and the *Herald*. Mr. Cole's object is to restate Rousseau's doctrine of the general will in such a way as to leave room for many other associations, industrial and religious, as well as the State. Mr. Cole's demand is for functional devolution of power for such associations, "a demand that the State itself should be regarded only as an association—elder brother, if you will, but certainly in no sense father of the rest." And if the individual finds himself torn between loyalty to the State and loyalty to the industrial body to which he belongs, we can only say, with Rousseau, that he ought to consider the good of the community as a whole.

Messrs. McDougall, Shand, and Stout write on "Instinct and Emotion"; Prof. Lloyd Morgan on Berkeley's doctrine of *esse*; Mr. A. Cock on the "Æsthetic" of Croce; Dr. Tudor Jones on the philosophy of values; Prof. A. Robinson on the philosophy of Maine de Biran; Dr. Aveling on "Some Theories of Knowledge" (his treatment is largely based on the recent work of Father Leslie J. Walker); and Miss E. E. Constance Jones and Messrs. Bosanquet and Schiller on "The Import of Propositions."

(2) Mr. G. A. Johnston has earned the gratitude of students of philosophy for collecting within a small compass the more characteristic passages from the works of Reid, Ferguson, Beattie, and Dugald Stewart. At a time when many are inclined to distrust the Kantian solution of Hume's sceptical difficulties it is interesting to read an alternative solution of these difficulties in the natural realism of the Scottish Philosophy of Common Sense. In a brief introduction Mr. Johnston gives an account of the relation of Reid and his followers to Locke, Berkeley, and Hume.

E. H. STRANGE.

DIRICHLET SERIES.

The General Theory of Dirichlet Series. By G. H. Hardy and Marcel Riesz. Pp. x+78. (Cambridge: At the University Press, 1915.) Price 3s. 6d. net.

IT is well known that Dirichlet made a new start in the theory of numbers by bringing it into connection with certain analytical functions of the form $\sum_h n_h^{-s}$, n_h being an integer, and s a real quantity. In the present tract the definition of a Dirichlet series is

$$f(s)=\sum_1^\infty a_n \exp(-\lambda_n s),$$

where (λ_n) is a sequence of real increasing numbers converging to $+\infty$, and s is a complex variable. This obviously includes Dirichlet's functions, and also those considered by Dedekind, Riemann, Landau, and others, in the same connection.

In the earlier chapters we have a summary of the known elementary properties of $f(s)$, such as the conditions of its convergence when regarded as a sum in the ordinary sense, and so on. But the most novel, and principal, part, due mainly to Dr. Riesz, is concerned with what he calls the summability (λ, κ) of $f(s)$. It is important that the meaning of this should be properly understood. Let s_n mean the sum of the first n terms of $f(s)$; then Dr. Riesz associates with this a function which we may call $\sigma_n(\lambda, \kappa)$, where κ is an arbitrary positive number, and λ is a functional symbol defined by $f(s)$ and κ, so that we have a sequence $[\sigma_n(\lambda, \kappa)]$ which we may consider as depending upon κ. If this new sequence has a limit L, we say that $f(s)$ is summable (λ, κ). In the definition we only consider the *formal* nature of $f(s)$, so that it does not matter whether $f(s)$, regarded as a series in the ordinary way, is convergent or not. Thus we have a sort of extension of the theories of Poincaré, Borel, etc., about divergent series.

The conditions that L may exist give properties of $f(s)$ considered as a formal expression, and hence certain conclusions of an arithmetical nature can be drawn. It is in the further development of these deductions that we may hope for further information of interest. The mere fact that from a sequence (s_n) we may be able to construct a sequence (σ_n) which agrees, in the limit, with (s_n) when the latter is convergent, and may be called its "sum" when it becomes divergent in the ordinary sense, is a barren definition until we apply it to something concrete; if we can do this, it may be a very valuable resource, as in the case of asymptotic summation. Everything goes to show that the + we use in writing infinite series is in some ways less appropriate than the comma of the old-fashioned "progressions"; it will not matter if we remember what we are doing, and that there is no such thing as the actual sum of an infinite number of terms.

One observation in this tract is liable to misunderstanding. It may be true that Cahen is the first to discuss $f(s)$ *systematically* as a function of a complex variable s; but the first step in this direction was taken by Riemann in his famous paper on the distribution of primes. To arithmeticians, at any rate, it is the development of Riemann's results that is of principal interest at present; other problems of the same kind naturally present themselves, as, for example, the frequency of cases where p and $(p+2)$ are both primes, like (5, 7) or (11, 13). The new analysis may throw some light on these and other dark places. In any case, this tract will be welcome for its concise statement of known facts, and its bibliography, which supplements that of Landau.

G. B. M.

OUR BOOKSHELF.

Fungoid Diseases of Farm and Garden Crops. By Dr. T. Milburn. Pp. xi+118. (London: Longmans, Green and Co., Ltd., 1915.) Price 2s. net.

THIS book is intended "primarily for the use of farmers, gardeners, and agricultural students," and it is hoped that it may assist also "those engaged in teaching and county lecturing." The essentials of a book fulfilling these aims must be that for the student the elementary scientific facts are correctly and clearly stated, and for the farmer and gardener that his understanding of the subject is developed by his attention being directed to general principles while practical help is given. This book falls short of this standard.

The farmer and gardener fail to get the knowledge they want when they are told that "no exact formula" can be given for making Bordeaux mixture, and that "it is always necessary to test the solution before applying, for if too much lime be present it is useless as a fungicide." While the author quotes the titles of recent works on the chemistry of Bordeaux mixture, it seems scarcely possible that he has read them from the account he gives of the chemical composition of Bordeaux mixture. The statement that the preparation of soda-Bordeaux is "somewhat critical," and that since this mixture "possesses no effectual advantage" it can be passed over, will considerably surprise the Irish Department of Agriculture and the numberless farmers who, under their tuition, have saved thousands of acres of potatoes from "blight" by the use of this "soda-Bordeaux" or "Burgundy mixture." The gardener and fruit-grower will not acquiesce in the strange statement that "washes of potassium sulphide" are "very effectual, but too expensive."

The book is well printed and very cheap; it would have been better, however, to have in-

creased its cost by greater care being given to its compilation and by enriching it with good reproductions of photographs of diseased crops.

A First Book of School Gardening. (First Books of Science.) By A. Logan. Pp. vi+151. (London: Macmillan and Co., Ltd., 1915.) Price 1*s.* 6*d.*

THE aim of school gardening in this country is too often merely to teach children to grow cabbages (and other crops) successfully. The author of this little volume, who is well known as a pioneer of school gardening in the north of Scotland, would, in addition, "instruct pupils in the fundamental principles of soil management and plant growth." This double aim is carried out by means of classroom lessons and practical work. "Neither of these types of work, however, has been allowed to encroach upon the other." The book is much more handy in size than the author's previous volume, and is better for being more concise. It will be welcomed by numerous teachers as being exactly what they want.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Modern Universities in China.

EVERYONE knows that the Chinese once led the world in scientific and material development. What may surprise Europeans who are unacquainted with the Far East is that they understood the principles of good engineering design long before our learned men in Britain had investigated such matters.

The arch, beautiful from the scientific as well as the æsthetic point of view, is frequently to be seen in parts of China which have only recently been explored by the white man. The undoubted antiquity of many existing examples proves that this type of structure antedates the arrival of the foreigner. Like printing and gunpowder and many other inventions and discoveries, it was probably of Chinese origin. The bridges, the pagodas, the city walls, and certain details of building construction to be seen in China demonstrate that many centuries ago there were men in that wonderful country who had a complete understanding of some most important principles used in applied science work.

Unfortunately there came a time when classical education alone was in favour. The disasters, political and economic, which have fallen upon the Chinese during their recent history have been in no small measure due to the paralysing effect of their educational system. About thirty years ago a very few people in authority in Peking realised this fact. During the last ten or fifteen years there have been violent changes in the outlook of millions of the people. The old ideas concerning education are almost dead. Western knowledge is in demand.

Many Chinese have entered the universities of Europe, America, and Japan. An effort has also been made to create universities in China. Anyone who has taken an interest in the lives of Oriental students in England must come to the conclusion that it is better to carry Western learning to China, rather than send Eastern students to Europe.

The number of modern universities in China is not great. There are some under the control of the various missionary societies, but of these there is only one (St. John's University, Shanghai) which has any real claim to the title. Other institutions, with praiseworthy ambitions but poor finances, connected with the work of evangelisation are the North China University, the Soochow University, and those known as the Shantung Christian, the Nanking, and the Boone (Wuchang) Universities.

The three which are under entirely secular control are the University of Hong Kong, the Government University of Peking, and the Peiyang University, Tientsin.

An important visitor to any of these centres of learning would come to the conclusion that there is only one of them which is entitled to be ranked with the provincial universities of England. The missionaries have not sufficient funds to obtain the necessary staff and equipment. The Chinese Government place the administration in the hands of Chinese officials, which is almost hopeless. Corruption still exists in high places, despite the changes due to the revolution of 1911.

The University of Hong Kong has already established itself as worthy of British traditions. It commenced its career in 1912, and after three years it has earned the confidence of both Chinese and Europeans in the Far East.

Two events which have recently occurred are significant. President Yuan has provided two thousand dollars per annum for scholarships, tenable by Chinese subjects. A wealthy Chinese, resident for many years in the Straits Settlements, has recently given the University a sum of money equivalent to about 30,000*l.* The conditions of his bequest are curious. He has lent the University half a million dollars, without interest, for twenty-one years.

A few weeks before this offer was received, a citizen of Hong Kong, named Ho Tung, presented the University with one hundred thousand dollars.

In order to show that the local Chinese are sympathetic to, and interested in, this centre of learning, it may be mentioned that a few months ago the writer obtained from them the promise of about one thousand pounds for a cricket pavilion for the Students' Union. This money was raised in a few days, despite the fact that everyone in the colony has given very freely to the various war funds.

The University buildings were presented by a wealthy Parsee, the late Sir Hormusjee Mody. The Government gave the site. An endowment fund, exceeding one million dollars, was collected by the Chinese. Messrs. John Swire and Sons, and affiliated firms, provided 40,000*l.*, and the first chair to be endowed in the University is called the Taikoo chair of engineering, as the Chinese name for this important mercantile house is Taikoo. Various other British firms in the Far East subscribed to the original endowment fund. The Government of the colony contributes 2000*l.* per annum, which the Chinese members of the Legislative Council think should be increased.

After an experience of three years, the University authorities have every reason to be satisfied with their work. There are now about two hundred undergraduates. The tuition fees are the equivalent of thirty pounds per annum, and, in addition, the student must pay for his board and lodging in one of the five hostels or colleges. It probably costs a parent about 100*l.* per annum to send his son to the University. This compares favourably with the cost of sending him to Europe or America. The engineering and arts

course is of four years' duration. The medical students must take at least five years to qualify for a degree.

The University of Hong Kong has already proved itself successful for the following reasons:—(1) The Chinese desire Western, and especially scientific, education; (2) the situation of the University is in geographical China, but security of life, property, and tenure of office is assured, because it is in a British colony; (3) repeated assurances have been given that the standard of the degree will be the same as that of the University of London; (4) the finances of the University are in a sound condition; this enables the council to obtain a numerous and well-qualified staff. It also makes possible suitable equipment and maintenance of the same.

There is a very great demand in China for instruction in applied science. More than a half of the total number of students in the University have selected the engineering course. The excellent equipment, now installed in the fourteen laboratories used by engineering students, has proved a great attraction. A tribute must be paid to numerous British engineering firms who presented the engines, machines, and apparatus. They proved their patriotism before the outbreak of the war.

The University is fortunate in its Principal and Vice-Chancellor. Sir Charles Eliot, C.B., K.C.M.G., etc., has an international reputation as a scholar, diplomatist, and administrator. He is a man of wide sympathies, and has obtained the confidence of those interested in educational affairs in China.

It would not be possible to be optimistic concerning the future of the modern universities in China were it not for the pioneer work of this British University. That it will continue to lead in the development of scientific work in the Far East is probable. It is a pattern for the Chinese Government when the great problem of education for the Republic is properly considered. Each year the famine and floods take their toll of life. The enormous mineral resources of the vast country remain undeveloped. Only scientific knowledge can save the nation. This fact is gradually becoming recognised. It is believed that the University of Hong Kong will train many of those who will take an active part in the economic development of China.

C. A. MIDDLETON SMITH.

The Aurora Borealis of November 5.

ON November 5, from 6.30 to 7.40 p.m., long after the last lingering trace of sunset had vanished, the heavens along the northern horizon were illuminated as if by an approaching dawn. A luminous arch of irregular shape, pale rose-lemon in colour, fluttered conspicuously as though agitated by a wind, portions moving north and south, others east and west, and growing and fading in intensity alternately. Between 6.50 and 7 a beautiful series of rays was manifested, projected apparently in front of the arch as shown in the accompanying illustration. Each ray, which was visible for not more than half a minute, faded away, to be as quickly replaced by others. They exhibited a slow bodily movement to the left, possessing a rotary motion, just as would the teeth of a revolving wheel. The arch itself was situated N.N.W., as will be seen from the stars shown in the illustration. The stars shone uninterruptedly through the entire luminosity. The temperature was 33° F., and the wind N.N.W.

Aurora of November 5, 1915, observed at Bramley, Yorkshire.

It will be noted that the phenomenon as witnessed was more or less a repetition on a minor scale of what is usually seen in the Arctic circle. We might assume that on the date in question the aurora possessed abnormal brilliance, and it was easy to imagine the polar landscape illuminated thereby.

SCRIVEN BOLTON.

Bramley, Yorkshire, November 9.

Science in National Affairs.

IN your article on "Science in National Affairs" (October 21) the subject of school science was referred to in such a manner as to awaken the interest of all science teachers, who will generally endorse the opinion of Mr. Buckmaster and of the writer of the article that the present position of science in our schools is inferior and unsatisfactory. The status of science in our secondary schools, in particular, must have an important bearing on its status in our national life, and now that the pressure of circumstances has caused a wave of national introspection, science teachers expect, and will welcome, any investigations which would lead to a more extended recognition of their claims. Though there may be much still capable of betterment in the practice of science teaching, it will be generally admitted that the comparative neglect and consequent want of success of school science are traceable to unfavourable external conditions, viz., the indifference of the general public, the conservatism of universities which control the curricula through their examination systems, and, connected therewith, the overwhelming preponderance of non-scientific headmasters.

The general question of the national neglect of science has been mooted so fully in the scientific Press that amongst scientific men there can scarcely be a doubter left. What is now required is some concentrated, organised effort to reach the general public and their representatives. Failing the Royal Society, the matter is essentially one for a body like the British Science Guild. Is it not time for isolated efforts to be co-ordinated, and for a definite, organised plan of campaign to be entered upon with the prime object of getting into touch with the general public, and of pressing the claims of science, *urbi et orbi?* The obstacles may be great, the prejudices many, but is it too much to ask that our scientific leaders should emerge from their seclusion, enter the arena, and show that touch of character which alone can supply the driving power for the realisation of reforms? Oh, for half an hour of Huxley!

E. H. TRIPP.

3 Milton Road, Bedford, November 5.

THE subject of this letter was suggested to me on reading the recent leading articles in NATURE, in which it is pointed out that the present lamentable lack of knowledge of scientific methods and activities on the part of our political leaders is due largely to the neglect of science in our schools.

I have taken the trouble to find out (from the "Schoolmaster's Yearbook, 1914") how many of the headmasters of our public schools hold academic qualifications testifying to their having received any kind of scientific training. Out of a total of 113 public schools—the number of schools represented last year on the Headmasters' Conference—there are 82 headmasters whose sole qualifications are in classics or theology (about half of these are in holy orders), 13 whose main qualifications are in mathematics, while the total number of entries showing any qualifications at all in science is 10. Of course, I do not wish to draw the conclusion from these figures that science teaching is neglected in the great majority of our public schools. On the contrary, I know well that excellent work is being done in most of them; but I do think that one may safely argue that under this state of affairs the spirit of respect for scientific knowledge is bound to suffer. How can that spirit of reverence and respect for science which is so lacking in our leaders be cultivated in the classical atmosphere of our schools where for so long science has been regarded as a subject on a slightly higher level than, say, book-keeping, and tolerated purely for its utilitarian value? In the school in which I myself teach, which is certainly, as regards laboratory accommodation, one of the best equipped schools in the country, and in the fourth forms which I take as most typical of the whole, a boy gives six periods a week to experimental science, including both physics and chemistry. The same boy gives no fewer than eight periods to Latin (or German as an alternative), while on the classical side of the school a boy may "complete" his school education without so much as ever hearing the names of Newton, Lavoisier, or Faraday.

Surely science will come to its own only when it is generally recognised and taught that the great natural truths and systems contain as much of what is noble, beautiful, and uplifting as anything yet revealed by the purely humanitarian studies. Moreover, if the true scientific spirit is not inculcated in our public schools, how can it ever reach the country as a whole while our political leaders and even our journalists are for the most part recruited almost direct from the public schools?

G. N. P.

Chemistry at the British Association.

WITH reference to the closing remark of the article with the above title in NATURE of November 4, "To the chemist this is perhaps more convincing than a volume of deductions by a physicist," the "this" being Dr. Whytelaw Gray's contributions to our knowledge of isotopes, I think it only fair to other chemists to point out that Dr. Gray is by no means the first or only chemist to study isotopes. Putting aside the numerous recent atomic weight determinations, which scarcely come under the category of volumes of deductions by a physicist, the beautiful researches of von Hevesy and Paneth had previously proved rigorously the chemical and electrochemical identity of lead and radium-D, which Dr. Gray has so far done only very roughly, though in his choice of some of the properties studied he broke fresh and interesting ground, and much is to be hoped from the continuation of the work. But even von Hevesy and Paneth only confirmed rigorously in this and a few selected cases what had been abundantly and comprehensively established by Fleck in this country, as they would be the first to point out. The benediction of other chemists on fundamental advances in their science is pleasant to have, no doubt, but if anything could be done to shorten the initial period of scepticism, which the history of this subject seems to show is necessary, it would be even more welcome.

F. S.

I AM much obliged to the Editor for giving me an opportunity of answering the letter from "F. S.," as I should not like him to think that the writer was oblivious to the work of experimenters other than Dr. Gray. Far from it: it is the very recognition of the work of the numerous physical chemists, in whose number (if I guess aright) "F. S." should be counted, that prompted the final remark. The whole difficulty appears to turn on the word "this." It was intended to mean experimental observation as opposed to theoretical deduction.

THE WRITER OF THE ARTICLE.

The Etymology of "Chincough."

I THINK your correspondent, "M. D." (NATURE, October 28), is wrong when he says that the Dutch word *kinken* means to cough. There *is* a Dutch verb *kinken*, at least I find it in the list of Dutch words of de Vries and te Winkel, but I never heard it, nor do I know its meaning. *Hoest* is the Dutch for cough (German *husten*); the verb is *hoesten*. *Kinkhoest* is whooping-cough (the Dutch *oe* to be pronounced like the German *u*).

A DUTCHMAN.

PREHISTORIC FLINT MINING.

THE numerous pits in the chalk at Weeting, Norfolk, commonly known as Grime's Graves, have long attracted attention, but the only exhaustive study of them made until last year was that of Canon William Greenwell, who proved in 1870 that they represent prehistoric flint mines. In the account of his results Canon Greenwell remarks that there "can be no doubt that the whole space occupied by the pits is a complete network of galleries," and he shows that the flint obtained from the mines was worked into implements on the spot. How extensive was this industry may be realised from the fact that the pits are from three to four hundred in number, and occupy an area of not less than twenty acres. They vary from about nineteen to more than eighty feet in diameter, and all are filled to within a few feet of the surface with material which seems for the most part to have been thrown in by the miners themselves.

From the whole of the evidence Canon Greenwell concluded that the flint-working was of Neolithic date, and subsequent researches at Cissbury and other localities where flint was mined seemed to confirm this conclusion. When, however, discoveries in the French and Spanish caverns revealed a regular succession of fashions in the making of stone implements, a study of the worked flints from Grime's Graves and Cissbury suggested that many of these were of a late Palæolithic rather than of a Neolithic pattern. The Prehistoric Society of East Anglia, therefore, with characteristic energy, decided to examine the question further, and in the spring of 1914 it undertook a most painstaking excavation and examination of two typical pits in the group of Grime's Graves. The work was done under the immediate direction of Mr. A. E. Peake, whose exhaustive report, accompanied by the valuable notes of several specialists, has now been published by the Society.[1]

FIG. 1.—End of gallery at bottom of pit showing three picks of deer antlers left by the miners adjacent to the layer of tabular flint (black) which they were working.

The mining seems to have been done chiefly with picks made of red deer antlers, of which no fewer than 244 were discovered in the two shafts and the galleries connected with them. Three of these picks, as they were left by the miners, are shown in the accompanying photograph (Fig. 1). Some were found to be so well preserved that even finger-prints could be distinctly observed on the adherent mud. The blocks of flint were

[1] Prehistoric Society of East Anglia. Report on the Excavations at Grime's Graves, Weeting, Norfolk, March–May, 1914. Edited by W. G. Clarke, Hon. Sec. (London: H. K. Lewis, 1915.) Price, 5s. net.

brought to the surface and chipped into implements on the spot, as indicated by the numerous spoil heaps or "floors," of which fourteen were examined.

Both in the spoil heaps and in the earth filling the shafts numerous flint implements were collected, and the chief forms are described, with fine illustrations, by Mr. Reginald A. Smith. None are polished, but some of them (Fig. 2) are of the typically Neolithic pattern, while others (Fig. 3) are more suggestive of the Palæolithic period. One is noted as being "a not uncommon type in the period of La Madeleine"; one resembles "the tapering portion of a Chelles *ficron*"; another has a "facetted butt in the Northfleet style"; others "cannot be matched anywhere but in Le Moustier deposits"; while at least two can only be compared with implements from St. Acheul. A typical Celt-like Neolithic implement "might well be regarded as an intruder" if the position of its discovery had not been known, and if a second exactly similar specimen had not been met with.

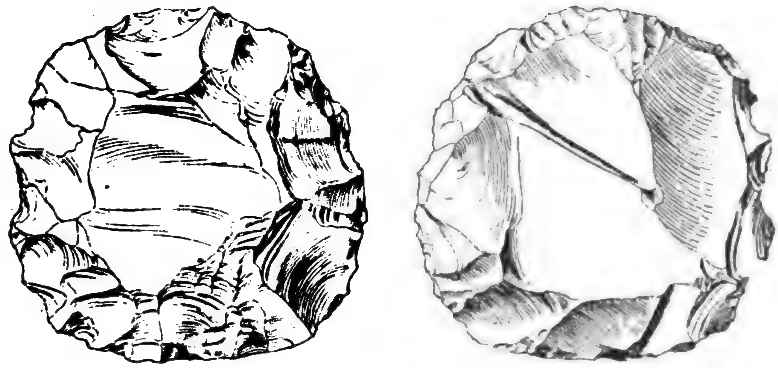

FIG. 3.—Disc-shaped flint implements, both faces, one-half natural size.

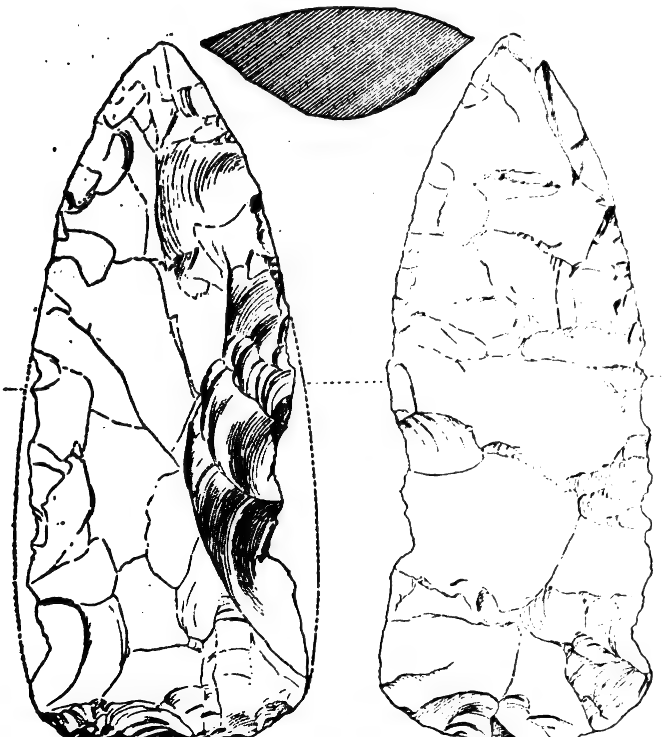

FIG. 2.—Celt-shaped flint implement, both faces and section, two-thirds natural size.

A geologist examining these implements would date them by the latest or Neolithic types which have never hitherto been found in Europe with the Pleistocene fauna. It is therefore very interesting to note that they are associated with pottery, with human remains of present-day type, with bones of animals which have either survived in this country until historic times or are still living, and with shells which are all of existing species. The charcoal found in the same deposits includes wood of the beech, which Mr. Clement Reid has never found in any undoubted Pleistocene formation in Britain. Local circumstances may have changed a little since the mines were worked, as suggested by the shells, which seem to indicate a moister climate than that of the present day; but the whole assemblage of remains is such as might have accumulated at any time between the Neolithic and the Historic period. A valuable account of similar flint mines in Sweden, appended to the report by Dr. N. O. Holst, leads to the conclusion that they were "worked, with or without a break, from the later portion of the Neolithic Age down to the Early Iron Age." The new excavations thus confirm and extend the results of Canon Greenwell already mentioned. The Prehistoric Society of East Anglia is to be congratulated on the thoroughness with which it has accomplished its task, and on the admirable manner in which it has published its detailed report. A. S. W.

THE UNIVERSITIES AND THE WAR.[1]

To discuss the principles and results of British education is perhaps not inappropriate at a time when the Empire is on its trial. For, next to racial soundness, education is an Empire's greatest asset. The issue of this war will certainly bring out new features of difference between the educational ideals of the chief groups of belligerents, and will develop no less certainly new cultural values. What those who take an interest in education probably will look for most is a strengthening and broadening of its scientific basis. No lesson has been more forcibly inculcated by the

1 "The Yearbook of the Universities of the Empire, 1915." Published for the Universities Bureau of the British Empire. Pp. xiv+717. (London: Herbert Jenkins, Ltd., n.d.). Price 7s. 6d. net.

war than the vital necessity, for national prosperity and national existence, of the organisation of applied science. Education may be said to be permanently in a state of transition, and this is to the good. Without change there is no development; without change there is only decay. Those who received, a quarter of a century ago, the standard classical education of a public school, now know that it was only a caste-system, suitable only (and that, too, only by prejudice) as a quasi-literary and so-called character training, for the barrister and the politician.

The growth of universities in recent years throughout the Empire, having as their main function the teaching of science, is the most hopeful feature of the present period of transition. *Ars longa, vita brevis;* the accumulation of important knowledge, year by year, to be added to the sum of man's understanding and control of his environment and resources, makes the task of learner and teacher alike more and more difficult, in a geometrical progression of difficulty. Here, therefore, is an occasion for revision of methods of teaching; also for economy of study. Old subjects must be scrapped, or side-tracked as luxuries. University education, again, must obviously commence earlier. It is encouraging to note that in the majority of the new universities of the Empire the age of entrance is more and more approximated to that adopted in the days when universities were first developed, viz., about sixteen.

The second issue of the "Yearbook of the Universities of the Empire" is a very useful work of reference, especially for young men going out to the Colonies and Dominions or coming thence to the mother-country. The educationist will find in it the more important details of the university equipment of the various countries of the Empire, how it meets the special needs of particular environments which call for special studies, and what response in attendance and results is made by the various communities. The volume is also a reminder of the fact that in 1912 a congress of the universities of the Empire was held in London, and a Universities Bureau of the British Empire was formed. The committee of the Bureau has thirteen members, and fifty-four correspondents act for the fifty-four universities. The hon. secretary is Dr. Alex Hill, who has edited the yearbook since Mr. W. H. Dawson joined His Majesty's forces.

The "comparative presentations," says Dr. Hill, "will, it is hoped, enable the authorities of universities to see at a glance what is being done elsewhere. To the student they will display the fields of knowledge which the several universities especially cultivate."

The Bureau will perform a great service to the Empire if it can link up scientifically all the mechanisms of the university education into an "Imperial Chain," and thus make the way clear for a consistent and scientific development of British culture. In the numerical returns there is, as the editor points out, a difficulty in checking, owing to the length of transit from overseas.

The fifty-four universities have attached to them two hundred and forty-two colleges. Outside Great Britain, among great institutions deserving special study, are the University of Toronto (which dates from the eighteenth century); the McGill University of Montreal; the University of Adelaide; and the Universities of Allahabad, Bombay, and Calcutta. To the last-named are affiliated forty-five colleges, an example of the organisation and thoroughness of the educational system which India owes to the British *raj,* and the success of which is proved by the achievements of so many native students in science and other subjects.

As regards special lines of study, one notes the development of metallurgical instruction at Sheffield and Johannesburg, of financial and commercial instruction at Birmingham, of forestry and agricultural instruction at various Canadian universities, and of the curious preoccupation with legal studies that obtains in, for instance, the Alberta University, which has seventeen lecturers on law, but none on botany. The attention paid to medicine, surgery, and dentistry is very noticeable, as on the mechanical side is that paid to engineering and applied science generally. In theoretical and applied science, universities like Cambridge, Birmingham, Bristol, and Toronto (to name a few) are very thorough in their curricula. Some Canadian universities present local peculiarities in catering for oratory, dogmatic and apologetic theology.

Private benefactors have done much in building up this nucleus of a scientifically educated Greater Britain. Such application of wealth is scientific; the foundation of free libraries, three-fourths of their contents being ephemeral fiction, is not.

A very interesting section of the Yearbook is the War Roll, which shows very clearly how the more highly educated section of the Empire's people has responded in the most practical way to the call of duty, which after all is another name for scientific sense. The editor estimates the number of students below military age as not less than five per cent. "A considerable proportion of university students have been rejected owing to physical unfitness, especially defective eyesight." This note should receive the attention of eugenists. The only possible method of estimate was "to give the number of students of the session 1913-14 who were known to be serving with His Majesty's Forces *plus* the number of freshmen who had withdrawn for this reason." This War Roll is a list to be proud of; the proportion of members of staff is remarkable. Not less remarkable is the number of commissions obtained, which is a significant datum for a voluntary army; no less is the number of men "in the ranks." Education, as Pericles observed long ago, is the best seed-bed for patriotic service; *noblesse oblige.*

A. E. CRAWLEY.

NOTES.

We notice with profound regret the announcement of the death on November 16, at sixty-six years of age, of Prof. Raphael Meldola, professor of chemistry in the City and Guilds of London Technical College, Finsbury.

The following is a list of those who have been recommended by the president and council of the Royal Society for election into the council for the year 1916 at the anniversary meeting on November 30:—*President*, Sir J. J. Thomson; *Treasurer*, Sir A. B. Kempe; *Secretaries*, Prof. A. Schuster and Mr. W. B. Hardy; *Foreign Secretary*, Dr. D. H. Scott; *Other Members of the Council*, Prof. J. G. Adami, Sir T. Clifford Allbutt, Dr. F. F. Blackman, Dr. Dugald Clerk, Sir William Crookes, Prof. A. Dendy, Prof. J. Stanley Gardiner, Dr. H. Head, Mr. G. W. Lamplugh, Prof. A. E. H. Love, Major P. A. MacMahon, Prof. R. Meldola (since deceased), Prof. A. Smithells, Prof. E. H. Starling, Mr. R. Threlfall, and Sir Philip Watts.

The Nobel prizes for 1914 and 1915 have now been awarded. According to the *Morning Post* the prize for chemistry for the former year is awarded to Prof. Theodore William Richards, of Harvard University, and that for physics to Prof. M. v. Laue, of Frankfurt-on-Main. The physics prize for 1915 is awarded jointly to Prof. W. H. Bragg (now of University College, London, but until recently professor of physics in the University of Leeds), and his son, Mr. W. L. Bragg. The chemistry prize goes to Prof. R. Willstätter, of Berlin.

We regret to see the announcement of the death, at fifty-six years of age, of Mr. Booker T. Washington, principal of the Tuskegee Institute, Alabama, whose labours for the practical education of negro students have been of untold benefit to the coloured people of the United States and West Indies.

The death is announced, in his forty-seventh year, of Mr. Wirt Tassin, who was a special agent of the U.S. Geological Survey at the Chicago Exposition, and from 1893 to 1909 was assistant-curator of the division of mineralogy at the U.S. National Museum. He had since been occupied as a consulting metallurgist and chemical engineer.

At the anniversary meeting of the Mineralogical Society, held on November 9, the following officers and members of council were elected:—*President*, W. Barlow; *Vice-Presidents*, Prof. H. L. Bowman, A. Hutchinson; *Treasurer*, Sir William P. Beale, Bart.; *General Secretary*, Dr. G. T. Prior; *Foreign Secretary*, Prof. W. W. Watts; *Editor of the Journal*, L. J. Spencer; *Ordinary Members of Council*, Dr. J. J. Harris Teall, F. N. Ashcroft, Prof. H. Hilton, A. Russell, W. Campbell Smith, Dr. J. W. Evans, Dr F. H. Hatch, J. A. Howe, T. V. Barker, G. Barrow, Dr. C. G. Cullis, F. P. Mennell.

Mr. F. W. Smalley makes a valuable contribution towards our knowledge of the significance of the plumage phases of the ducks in the November number of *British Birds*. He surveys not only the adult, but also the nestling-down plumages. Out of the wealth of material obviously at his disposal it is to be hoped that in the immediate future he will complete the records which he has made of the several species of British ducks, and especially of the "diving-ducks."

Parasitologists will find some valuable notes on the eggs of *Ascaris lumbricoides*, by Mr. L. D. Wharton, in the *Philippine Journal of Science* (vol. x., sec. D, No. 2). The author obtained his material from autopsies at the city morgue, and has devoted special attention to "atypical" eggs, such as have been mistaken for the eggs of other species. Eggs lacking the mammillated outer layer have been laid together with typical eggs by the same female, isolated in Kronecker's salt solution, in the laboratory. He also gives the characters by which unfertilised can be distinguished from fertilised eggs, and abnormal features apparently induced by artificial conditions.

The *Scottish Naturalist* for November contains an admirable "Interim Report on the Aberdeen University Bird-migration Inquiry," by Mr. A. Landsborough Thomson, now serving his country "somewhere in France." This inquiry, it may be remembered, has been started for the purpose of tracing the wanderings of birds, mostly nestlings, marked at the nest with a metal ring bearing a number, enabling their captors, at a later date, to record the date and place of capture, and thus to establish the wanderings of that particular bird. Hitherto the co-operators in this scheme have been allowed to mark birds almost indiscriminately; to attain a higher efficiency, and to economise labour, selected species only are henceforth to be marked. Such are birds which are procurable for ringing in large numbers, which afford a fair percentage of re-appearance records, and the migratory movements of which are of sufficient interest to repay close investigation. The lapwing, woodcock, mallard, blackbird, and song-thrush are specially mentioned as fulfilling these conditions, a fact which may well be noted by those who desire to assist in this most promising investigation.

Although the recent Crinoids have been the subject of much study, and the group may now be regarded as fairly well known from the point of view of morphology and classification, our information as to the habits and mode of life of the living animals is almost confined to the common European species of Antedon. Two important contributions on this subject are published in the eighth volume of "Papers from the Department of Marine Biology of the Carnegie Institution of Washington," among the results of the recent expedition sent by the institution to Torres Straits. Mr. H. L. Clark has investigated the habits and reactions of many species of Comatulids occurring at Torres Straits, and finds that the different genera and families show important differences in the methods of locomotion and feeding, and in their responses to various stimuli. He especially combats the view that the crinoids are predominantly sessile organisms, and he finds that while members of certain families, such as the Comasteridæ, "do not swim, but only creep about by the use of the arms," others are

good swimmers and possibly capable of "real migrations." As regards food, he found that the species investigated were almost exclusively vegetable feeders, and were most abundant in situations where a rich phytoplankton was accessible. All were negatively phototactic, and were markedly intolerant of even a slight increase of temperature, although they appeared indifferent to considerable variations in the salinity of the water. A paper by Mr. F. A. Potts, on the fauna associated with the crinoids of a tropical coral reef, describes in detail an extraordinary list of Crustacea, Ophiurids, Polychætes, Myzostomes, and Molluscs, living as commensals or as parasites on the crinoids of the same region. In all these a more or less close resemblance to the host in colour and colour pattern is observed, and in some cases where the host species is variable in colour the commensal shows a coincident variability. The phenomena are compared with those investigated by Gamble and Keeble in Hippolyte, and, as in that case, the mechanism by which this resemblance is brought about remains obscure.

THE "Flora of New Mexico," by Messrs. E. O. Wooton and P. C. Standley, forms vol. xix. of Contributions from the United States National Herbarium. The flora is a list of all the species of phanerogams and vascular cryptogams at present known to occur within the State, and keys to the families, genera, and species are also given. New Mexico embraces an area of 122,000 square miles, and many portions of the area have not yet been botanically explored, so that it is probable the number of known species, now nearly 3000, will be increased in the future. The volume is based very largely on the personal observations of the authors, Mr. Wooton having spent some twenty years in New Mexico, but all other available material has also been examined. The book consists of 793 closely printed pages, and is published with a complete index and a geographic index. Under each species the type locality is recorded, and the range is given. Among the most largely represented families may be mentioned Compositæ, 158 genera and 585 species; Leguminosæ, 32 genera; 189 species; Scrophulariaceæ, 22 genera, 100 species; Cruciferæ, 30 genera, 101 species; and Gramineæ, 74 genera with 270 species.

IN commemoration of the twenty-fifth anniversary of the founding of the Missouri Botanical Garden by Henry Shaw in 1889, a celebration was held at Missouri on October 15–16 of last year, to which American and foreign botanists were invited to attend and contribute papers. The anniversary Proceedings have recently been issued in a volume of 400 pages, and form vol. i., Nos. 1 and 2, of the Annals of the Missouri Botanical Gardens. The speeches given at the banquet occupy the first thirty-two pages, and in the opening speech the history of the garden is detailed. Among the papers published, which were presented at the meeting, may be mentioned "The Vegetation of Mona Island," by Dr. N. L. Britton; "The Flora of Norway and its Immigration," by Dr. N. Wille; "The Phylogenetic Taxonomy of Flowering Plants," by C. L. Bessey; "The History and Functions of Botanic Gardens," by A. W. Hill; a paper on the colloidal properties of protoplasm, by Dr. F. Czapek; "The Law of Temperature connected with the Distribution of Marine Algæ," by W. A. Setchell; "Phylogeny and Relationships in the Ascomycetes," by G. F. Atkinson; and "A Conspectus of Bacterial Diseases of Plants," by E. F. Smith.

THE East Anglian Institute of Agriculture has issued a leaflet on the composition and value of feeding stuffs which should help farmers to compound the most economical rations for all classes of stock. Information of this kind is of special importance at the present time as many of the better-known feeding stuffs have advanced considerably in price, while several new foods have come on the market which can often be profitably substituted for them. Analyses are given of more than one hundred different foodstuffs examined at the Chelmsford laboratories, together with simple directions for calculating their value from the analytical figures. By comparing the calculated value with the market price, the farmer may protect himself against the excessive prices often charged for compound cakes and meals. As one example of the method, it is shown that linseed cake has a calculated value of 9*l.* 6*s.* a ton, and is not worth the present market price of 11*l.* 17*s.* unless required for some very special purpose. Farmers in Essex and Hertfordshire can have a copy of the leaflet free on application to the principal of the institute, Chelmsford.

"A STUDY of Soil Erosion and Surface Drainage in India," by Mr. Albert Howard, is published in Bulletin No. 53 of the Agricultural Research Institute, Pusa. Enormous quantities of valuable soil are annually lost throughout India, owing to unrestricted erosion caused by rain-wash. This erosion leads to waterlogging, which in turn, by destroying the porosity of the soil and by causing denitrification, leads to further damage. Erosion occurs both on the hills and in the plains. Thus, in the hill tracts of Ceylon, when the forest canopy was removed to allow the land to be put under coffee, now succeeded by tea, no provision was made to retain *in situ* the fine soil of the original forest, and as a consequence the fertility and water-retaining power of the soils of the tea plantations have been much reduced, necessitating the expenditure of large sums on manures. Mr. Howard urges that where forest land is sold for agricultural use, a regulation to terrace it immediately should be enforced. As remedies against erosion and waterlogging in the alluvial tracts of peninsular India, he advocates embankments and surface drainage. He describes in detail a special method of drainage which has been worked out of late years at Pusa, and is now being adopted on the indigo estates of Bihar. The aim of this method is to retain the fine silt on the land. To carry out the Pusa system, drainage maps, as originally devised by Sir Edward Buck, are recommended, as they have proved to be more useful than professional level maps. Soil-protection works in Central India are described by H. Marsh in an appendix to the bulletin.

DISCOVERIES of nearly complete skeletons of the primitive amphibians or Labyrinthodonts are becoming numerous and widespread. A group of several specimens of a species named *Myriodon senekalensis* has been found in a quarry in the Karoo formation near Senekal, Orange Free State, and is described by Dr. E. C. N. van Hoepen in the Annals of the Transvaal Museum, vol. v., part 2 (August, 1915). The head alone is imperfect, the other bones being well preserved in their relative natural positions. In general characters the skeleton agrees with that of the European and North American Permian forms, in which the vertebræ are represented by separate pleurocentra and hypocentra. The only peculiar feature is the presence of a mosaic of very thin polygonal plates, each bearing minute denticles, covering the interpterygoid vacuities of the palate. These may have been plates in the skin between the rami of the lower jaw; but the fact that their teeth are identical with those on the pterygoid bones suggests that they may have been loosely fixed in the roof of the cavity of the mouth.

A FEW years ago the American Museum of Natural History, New York, obtained from a Cretaceous formation in Montana, U.S.A., remains of the largest known carnivorous dinosaur, with a skull very like that of the familiar Megalosaurus, but not less than 5 ft. in length. A plaster cast of this skull is exhibited in the Geological Department of the British Museum (Natural History). Considerable parts of two skeletons have now been restored and mounted in the American Museum, in the attitude of combat over a skeleton of the herbivorous dinosaur Trachodon. As restored, the skeleton is closely similar to that of the other megalosaurs, with heavy hind-quarters and a long swimming tail, very small fore-quarters, grasping fore limbs, and a relatively large head. The total length is 47 ft., and when the body is raised in the attitude of walking on the hind limbs the height to the top of the head is about 20 ft. Photographs of the specimens, with a hypothetical restoration of the living animals, are published in the *Scientific American* for October 9 (vol. cxiii., No. 15).

THE Geological Survey of England and Wales has just issued a second edition of the very important memoir on "The Coals of South Wales," the first edition of which appeared in 1908. It will be remembered that this memoir was devoted mainly to an attempt to solve the problem of the origin of anthracite, and for this purpose very numerous analyses of the coals of the South Wales coalfield were made and collected, and were tabulated in such a manner as to serve to show the progressive change of the coals from steam coals into anthracite on traversing the coalfield in a north-westerly direction. This is shown on charts by what Dr. Strahan terms lines of *iso-anthracitism*, that is, lines drawn through points in the different seams where the ratio of the percentage of carbon to the percentage of hydrogen is the same. This ratio affords a good measure of the anthracitism of a coal, and lines drawn in this manner indicate clearly the direction and rate of progress of the gradual change from steam coal to anthracite. In the new edition some 118 additional analyses are included, and these have been found to be of considerable assistance in completing and adjusting the positions of the iso-anthracitic lines. It is noteworthy that this large number of new analyses, which add more than 50 per cent. to the original number, fall quite readily into their place in accordance with the original scheme, and have not necessitated any serious change in the positions of the iso-anthracitic lines, or any modification of the theory of the origin of anthracite put forward in the original memoir. The work of the last six years may therefore be looked upon as affording valuable confirmation of the conclusions arrived at in the first edition of this important piece of work.

THE Mersey Docks and Harbour Board has issued the report of the Liverpool Observatory for the year 1914. Time signals are given each day except Sunday by the firing of a gun in the Morpeth Dock, worked automatically from the observatory, and showing Greenwich mean time. Earthquake instruments are in regular use, and experiments are being made with a seismograph designed by Mr. J. J. Shaw, the results of which are said to be eminently successful. A table is given of the earth tremors that have been registered during the year. Astronomical observations continue to be made with unbroken regularity, and the solar eclipse of August and the transit of Mercury last November were well observed. For the meteorological side of the observatory the self-recording instruments for the automatic registration of atmospheric pressure, the force and direction of the wind, and the amount of rain are said to have worked without failure the whole of the year. A table is given showing the total amount of sunshine on each day throughout the year, also a table showing the maximum wind velocities on each day, and detailed daily meteorological observations are given for various elements. The control of the observatory remains under Mr. W. E. Plummer.

A SUMMARY of rainfall, mean temperature, and sunshine for the third quarter—July, August, and September—during the thirty-five years 1881 to 1915 has been issued by the Meteorological Office as an appendix to the Weekly Weather Report. The heaviest rainfall for the period in 1915 was 275 mm. in the east of Scotland, which is the only occurrence of the fall being heavier than in the north or in the west of Scotland, according to the means for the several lustra from 1881 to 1910, or in the several seasons for the individual years from 1911 to 1915. An examination of the results for the individual years of the several lustra also show no instance of the rainfall for the three months being greater in the east of Scotland than in both the north and west. The percentage of the average rainfall in 1915 was largely in excess in all the eastern districts, the mean being 122 per cent., while for the western districts the rainfall was everywhere deficient except in the south of Ireland, the mean of all districts being 88 per cent. of the average. The highest mean temperature for the three months in 1915 was 60·0°, in the English Channel, and the lowest 54·1°, in the north of Scotland; the excess or

deficiency from the average nowhere amounted to 1°, and was generally only a few tenths of a degree. Bright sunshine was generally slightly in excess of the average in the western districts, and there was a slight deficiency in the eastern districts.

THE report on the Survey of India for 1913–14 records much useful work. The new topographical survey makes steady progress. More than 300,000 square miles have been done since 1905, but about half a million remain to be done. About one-sixth of the total number of one-inch sheets of the map of India are now published, and a half-inch map is proposed. Of the quarter-inch map some new sheets were published, making a total of 18 out of 450. Most of the sheets of India, Afghanistan, and Baluchistan on the one-millionth scale are ready. Layer colouring has been adopted for the more recent ones. The scale of tints is still to be the subject of experiment. Several sheets of the international one-millionth with the Pàris colour scheme are in preparation. During the year three sheets of Afghanistan, Baluchistan, and Northern Persia on a scale of 1 to 2,000,000 were published. The sheet of southern Persia previously appeared. Others of India on this scale are in preparation.

HYDROGRAPHICAL investigations in Faroe waters form the subject of a paper by J. P. Jacobsen in *Meddelelser fra Kommissionen fer Havundersøgelser* (Bind ii., Nr. 4, 1915). In Trangisvaag Fjord, where most of the work was done, it was found that the water-level changed with the barometer, but that the influence of prevailing winds was extremely slight. A fourteen-day period of change was also observed. Investigations on the currents of the waters between the Faroes and Shetland bear out Nansen's previous discoveries, that the north-going current along the Shetlands is strongest where the depth is between 150 and 200 metres. The same is the case with the south-going current along the eastern side of the Faroe plateau. The lower surface temperature and salinity over banks than in adjacent waters in the north-east Atlantic has more than once been noted. This phenomenon Mr. Jacobsen believes he has traced to the greater mixing of the upper and lower water on the banks than elsewhere, due largely to strong tidal currents. In deeper places the mixing was far less pronounced.

PROF. IGNAZIO GALLI, whose notes on lightning we have had occasion from time to time to cite, recently published an account of a lightning stroke which fell on January 25, 1915, in Rome, upon the Church of San Gioacchino in Selci. He himself witnessed from a distant house a brilliant light of an orange colour and heard a single sudden explosion. He believed it to be a case of globe lightning. Subsequent inquiry of witnesses in the neighbourhood confirmed him in the opinion; they described the appearance as a red or reddish globe, 40 to 45 centimetres in diameter, which, moving over the roofs from north towards south, struck the cross of the church with a blinding light and a deafening crash. It is singular that Prof. Mengarini, of Rome, when a student at the Technical Institute, near San Pietro in Vincoli, witnessed a similar lightning stroke fall on the same church on February 28, 1876.

CIRCULAR No. 38 of the Bureau of Standards, Washington, a third edition of which has recently been issued, deals with the subject of testing india-rubber goods. Both physical and chemical methods of testing are included in the descriptions. It is pointed out that the constantly increasing demand for rubber goods by the general public, by railway companies, and other large consumers, indicates the necessity for developing standard specifications and tests for rubber, as has been done in the case of iron and other materials. In connection with the chemical tests, explanations are given showing the significance of certain determinations and the reasons for making them. This is done, for example, as regards the acetone extract, the sulphur, the waxes, and the extracts obtained with chloroform and with alcoholic potash; the idea being to enable a person who knows but little of rubber chemistry to understand the import of these analytical data. The operations as carried out by the bureau are set out in some detail, and, in addition, a specification and suggested method of analysis for rubber insulation compounds adopted by the Joint Rubber Insulation Committee are included for general information, though not officially endorsed by the bureau. Those interested in the subject may find it useful to consult the circular, which is a convenient epitome of the usual tests.

To meet modern conditions governing condensation of steam in power plants, it has become usual to extract the air and water from the condenser by independent means. High-speed centrifugal pumps provide very effective means of removing the condensate, and various forms of steam and water-jets, or pumps, are in use for the removal of the air. An interesting example of one of these new forms of air pumps—on the Williams-Müller system—is described in *Engineering* for November 12. The system is applied to a condenser for a 8500-kw. turbine at the Sheffield Corporation power station. This condenser is to give a vacuum of 28·5 in. at full-load output when supplied with circulating water at 62° F. The jet-pump is in principle identical with the common filter-pump used in laboratories, but much experiment has been necessary in order to determine the most suitable arrangement and proportions. In a trial of one installed at Glasgow, it was found that, starting with the condenser full of air at atmospheric pressure, a vacuum of 20 in. was attained in 2½ minutes, and 29 in. in 8 minutes.

THE annual report of Lloyd's Register for 1914–15 was published recently, and it is interesting to note that, in spite of losses owing to the war, the tonnage classed with Lloyd's for the year ending June 30 last was 300,000 tons in excess of that classed for the previous year. More than 300 vessels have been built, or are being constructed, on the Isherwood system of longitudinal framing; the tonnage of these vessels amounts to 1,675,000 tons gross. There are 290 vessels now classed for the carrying of petroleum

in bulk, and there is a large and increasing demand for such vessels. Proposals have been approved for the carrying of oil in circular tanks placed in the holds of ordinary cargo steamers. Several geared-turbine vessels have been approved during the year. Two are being built in the United States in which Curtis turbines are to be installed; the speed reduction in these ships will be from 3500 revolutions per minute at the turbine to about 90 at the propeller. There are now thirty-eight vessels classed at Lloyd's which are fitted with Diesel engines. The granting of scholarships has been postponed until the end of the war; those postponed will be available then, in addition to those which will be open in the ordinary course of events. The use of wireless telegraphy and submarine signalling increases rapidly, and there are now on the society's books 2939 vessels fitted with wireless, and 947 fitted with submarine signalling apparatus.

WITH its issue of October last, the American magazine known for many years as the *Popular Science Monthly* changed its name to the *Scientific Monthly*. The old name has been transferred to a second contemporary, the *World's Advance*, which will in future be known as the *Popular Science Monthly and World's Advance*. The functions of the two magazines as now arranged will be quite distinct. The *Scientific Monthly* will publish articles which appeal especially to educated readers as opposed to purely popular matter intended for the public generally; the *Popular Science Monthly and World's Advance*, to quote the magazine itself, "presents to its readers the new, the practical, and the unusual in modern science, mechanics, and electricity." It will strive to be a fascinatingly interesting, easily grasped, and trustworthy monthly record of the latest achievements in science, invention, and industry.

MESSRS. J. AND A. CHURCHILL announce the early publication of "Catalysis and its Industrial Applications," by E. Jobling, and a new edition of "An Introduction to the Physics and Chemistry of Colloids," by E. Hatschek.

OUR ASTRONOMICAL COLUMN.

PARALLAXES OF 70 OPHIUCHI AND 6 CYGNI.—Photographic measures of the parallaxes of these binary systems have been made by Prof. S. A. Mitchell at the McCormick Observatory, University of Virginia (*Astrophysical Journal*, October, 1915), using the 26-in. Clark refractor, the same aperture, it will be noted, as that employed at Greenwich on similar work. The results obtained are as follows:—

(1) 70 *Ophiuchi*.

Brighter star (4·3 mag.) $\pi = +0.145'' \pm 0.007''$
Fainter star (6·0 mag.) $\pi = +0.165'' \pm 0.007''$

(2) 6 *Cygni*.

Brighter star (6·6 mag.) $\pi = +0.051'' \pm 0.006''$
Fainter star (6·8 mag.) $\pi = +0.036'' \pm 0.007''$

THE SOLAR ECLIPSE OF 1916, DECEMBER 24.—The Rev. William F. Rigge, S.J., has worked out particulars regarding this eclipse (Monthly Notices, R.A.S., No. 9, 1915). Visibility is restricted to a small area of the Antarctic Ocean midway between the Cape of Good Hope and the south pole. Theoretically the conditions are noteworthy, and have raised special difficulties in the construction of the map. At maximum only 0·011 of the sun's diameter is obscured from a point about 32° E. long. and 66° S. lat., the sun being on the horizon. The moon's penumbra barely overlaps the earth, and as the date is so close to the winter solstice the penumbra falls on the Antarctic circle *beyond* the south pole, and consequently moves *against* the diurnal rotation. Further, for some places it is an eclipse of the Christmas midnight sun.

THE RADIAL VELOCITIES OF FIVE HUNDRED STARS.—The power of the 60-in. reflector is strikingly manifest in the latest list of stellar radial velocities by Dr. W. S. Adams (Contr. Mt. Wilson Solar Observatory, No. 105). The stars included are mostly fainter than 5·0 mag., but there are many fainter than 8·0 mag., and at least one fainter than 9·0. The velocities for all these stars depend on three or more observations. The table gives type of spectrum, total proper motion observed, radial velocities, and velocities corrected for solar motion. Determinations of about fifty of the stars have been made at other observatories, chiefly at Lick, and notwithstanding the greater dispersion employed at that observatory, the agreement is remarkably good. Incidentally, velocities of about thirty-four additional parallax stars are included. Some stars of special interest are:—AOe 14320 (spect. GO) with the high velocity of +299 km./sec., which, combined with its proper motion and parallax, gives an absolute velocity of 577 km./sec., and Boss 2647; although this star has a spectrum of the A type, it has the high radial velocity of +87 km./sec.

THE COLOUR INDEX OF S CEPHEI.—In several ways S Cephei is an object of exceptional interest. It is at once a circumpolar variable of long period, and one of the deepest coloured of red stars. The special importance of obtaining data concerning it is obvious, but, unfortunately, not less obvious are the observational difficulties it presents. At Harvard Observatory attention has been paid to it for many years, and lately Miss H. S. Leavitt has made a preliminary study of its colour index (Circ. Harv. Coll. Obs., No. 188), partly on the basis of observations made in 1897. The extraordinarily large value of the colour index puts this star beyond reach of the Harvard prismatic cameras using ordinary plates, whilst with yellow screen and plates stained with erythrosin there results an image nearly monochromatic, the effective light having a wave-length of about 5600 tenth metres. Düner, however, was able to classify its spectrum (Type IV.!!) by visual observation. The results drawn from a comparison of visual and photographic magnitudes of the star have been confirmed by a series of photographic photovisual observations. It appears that S Cephei has a colour index of fully five magnitudes at its maximum phase. Increasing as minimum is approached, it may reach six and a half magnitudes, whilst the visual and photographic maxima are probably not simultaneous. It may be added that the visual magnitudes range from 7·70 to 10·8 mag., whilst photographically the range is 12·62 to <16·0 mag.

MARINE BIOLOGICAL RESEARCH.[1]

THE annual report on the investigations carried on during 1914–15 by Prof. A. Meek and his colleagues contains papers of general interest. Mr. Storrow writes on several faunistic records, and Mr. T. Bentham contributes a note on what appears to be a new hæmogregarine from the skate. The purely

[1] Report for 1914–15 of the Dove Marine Laboratory at Cullercoats, Northumberland. (Published for the Northumberland Sea-Fisheries Committee.)

fishery investigations consist of an account, by Prof. Meek, of the migrations of the grey gurnard. The eggs and pelagic larvæ of this fish drift passively inshore towards the Northumberland coast with the general set of the current, and with increasing size they then move offshore. The migrations are correlated with the direction of the movements of the water, but it is more probable that the seasonal variation of temperature is a more important factor. Study of the general direction and the annual shifting of the isotherms would bring out this relationship. Prof. Meek also writes on the migrations of the dab. Mr. Storrow has accounts of the age and rate of growth of herrings and pilchards taken off the coast of Northumberland. The herring investigations form part of the general scheme of biometric research carried on by the Board of Agriculture and Fisheries, but only data referring to the age of the fishes, as determined by a study of the scale-markings, are discussed in this report.

Mr. J. H. Paul contributes an interesting account of the phenomena of autotomy in the Decapod Crustacea, with reference mainly to the lobster and crab. It is well known that injury to, or forcible retention of, a limb leads to the breaking of the latter. Escape is suggested as the object of autotomy on the part of the lobster, but more often a limb is thrown off by the crab as the result of injury and as a means of arresting hæmorrhage. Mr. Paul has studied the anatomy of the parts affected, and has also made experiments on the actions of the muscles and nerves involved. His figures are rather difficult to follow, but he shows that autotomy of a limb always occurs by a fracture in the exoskeleton running partially round a "breaking-groove" in the third segment of the limb. The fracture is a pluri-segmental reflex, and it is effected as the result of antagonistic muscles. It occurs, in the lobster, in about four seconds after nocuous stimulation. J. J.

JAMES GEIKIE'S RESEARCHES IN GLACIAL GEOLOGY.

AT the meeting of the Royal Society of Edinburgh on November 1, Dr. J. Horne, F.R.S., president of the society, delivered an address on "The Influence of James Geikie's Researches on the Development of Glacial Geology." At the outset reference was made to the appointment by the council of a committee to conduct investigations in connection with submarines, aeroplanes, asphyxiating gas, and high explosives. The experimental work had been carried out with the financial aid of an anonymous donor, whose generosity and patriotic spirit had been highly appreciated by the council.

The subject of the address had been chosen because James Geikie's researches in Glacial geology were the most striking feature in his scientific career. They stimulated inquiry and at the same time aroused keen opposition. Brief allusion was made to the state of research in this country when he began his investigations, how glacial phenomena were erroneously attributed to the action of icebergs, and how the clue to the correct interpretation was furnished by Agassiz during his visit to Scotland in 1840. From the evidence which he obtained in the midland valley and in the Highlands he inferred that glaciers formerly existed there in post-Tertiary time.

The land-ice theory of Agassiz was adopted and confirmed by Buckland, Ramsay, Archibald Geikie, and Jamieson, but nearly a quarter of a century elapsed before the accuracy of this interpretation was adequately recognised. As James Geikie's field work in the Geological Survey proceeded he evolved certain ideas regarding changes of climate in Pleistocene time, based on the succession of boulder-clays with intercalations of sand, gravel, and peat, and on the cave deposits and Palæolithic gravels in the south of England, which he afterwards published in 1874 in his volume "The Great Ice Age." He therein gave an account of the Glacial and post-Glacial deposits of the United Kingdom, Scandinavia, Switzerland, and North America. Through the whole description runs the principle, which he believed to be fundamental, that the Glacial epoch was not one continuous age of ice, but consisted of a series of cold and genial periods. In his discussion of the question of the age of the Palæolithic gravels and cave deposits in the south of England, he opposed the view held by many that they were post-Glacial, and referred them to inter-Glacial or pre-Glacial times. As regards the commingling of northern and southern mammals in these deposits, he combated the theory that this assemblage was due to seasonal migrations. He contended that the phenomena pointed to changes of climate.

These were the essential points in James Geikie's teaching which he never discarded. They encountered persistent opposition from the monoglacialists, who maintain the unity of the Glacial epoch, and ascribe the intercalated deposits to local movements of recession of the ice within one period of glaciation. Attention was next directed to his elaborate classification of European deposits, comprising six Glacial epochs separated by five genial periods. It was suggested that the fifth and sixth cold phases were not sufficiently severe to entitle them to be ranked as distinct Glacial epochs. If we eliminate the two last cold phases, his classification agrees with that of Penck and Brückner in the Alps. The evidence furnished by the Eemian clays, the Hötting breccia, the Dürnten lignite, the Don Valley section near Toronto regarding climatic changes in inter-Glacial time was reviewed. The opinion was expressed that sufficient evidence had been obtained to establish the general principle of oscillations of climate in the Glacial epoch, though the number of inter-Glacial periods may remain a subject of controversy.

ZOOLOGY AT THE BRITISH ASSOCIATION.

AT its first meeting Section D heard with profound regret that owing to serious illness the President of the Section, Prof. E. A. Minchin, was unable to be present. The presidential address, his last work, was read by Mr. Heron-Allen, and a telegram was then sent to Prof. Minchin conveying to him the sympathy of the section and thanking him for his able address. The following is a summary of the communications presented to the Section.

The Relation of Chromosomes to Heredity.

In opening a discussion on this subject Prof. MacBride said that there seemed to be no escape from the position that the chromatin, viewed as a whole, is the bearer of the hereditary tendencies, for the influence of the father in determining the character of the offspring is as potent as that of the mother. The head of the spermatozoon, which is the only part of the father which enters into the constitution of the progeny, appears to consist practically exclusively of chromatin. The formation of the organs of an embryo is known in many cases to be due to substances localised in the cytoplasm, but the formation of these substances can be shown to be due to chromatic emission from the nucleus of the unripe egg. Prof. MacBride then considered the difficult

question whether individual chromosomes are the bearers of different characters or groups of characters. The experiments of E. B. Wilson and his school on Drosophila and other insects suggest that they are. The best instance is the so-called sex-chromosome, which is supposed to carry the determiner of sex and of the qualities which are sex-limited. In some cases the female nucleus possesses one more chromosome than the male, and there are two kinds of spermatozoon, one with one more chromosome than the other. Hence it is assumed that sex is fixed by the spermatozoon. But when two species are crossed, differing in a secondary sexual character, the distribution of this character in the hybrid and in the F_2 generation shows that it cannot possibly be carried by the sex-chromosome. Moreover, in other cases (Abraxas) the inheritance of characters in a cross between two varieties indicates that there are two kinds of egg and one kind of sperm, and yet no constant chromosomal difference between the two kinds can be detected (Doncaster); in other words, the odd chromosome may not be the cause of sex-difference, but in itself the result of that sex-difference. Prof. MacBride pointed out that the phenomena of meiosis, and their agreement in form with the sort of segregation of qualities postulated by the Mendelian hypothesis, suggest that determiners of various characters are situated in definite pairs of chromatin units which become separated from one another at the meiotic division. Since, however, the number of allelomorphic characters can in many cases be proved to be much larger than the number of chromosomes, the individual chromosomes cannot represent these determiners, though they may perhaps represent groups of determiners.

Prof. Dendy pointed out that the present controversy on the subject of heredity is to a large extent a revival of the old quarrel over epigenesis and preformation. The preformationists are represented at the present day by that large body of biologists who consider that separately heritable, individual characters are represented in the germ-cells by definite material constituents—determinants, "factors," etc. The phenomena of mitosis indicate clearly the great importance of the chromatin substance of the nucleus, and are in complete accordance with the view that this chromatin contains the invisible factors or determinants. But perhaps the strongest evidence of the correctness of this conception is Gates's demonstration of the correlation between abnormal distribution of the chromosomes in the reduction division of the nucleus and the phenomena of mutation as exemplified in Œnothera. Prof. Dendy stated that there appeared to be no justification for the assumption that the entire organism is made up of separately heritable "unit characters," for ontogeny is essentially an epigenetic process. After referring to the influence of the environment on the organism and to the dependence of progressive evolution on the continuance of environmental change from generation to generation, Prof. Dendy directed attention to the great complications introduced by the sexual process, or amphimixis, whereby slightly different samples of germ-plasm are mingled in ever-increasing complexity from generation to generation. Through the oft-repeated process of amphimixis the chromatin of the nucleus comes to contain a great and varied collection of samples of ancestral germ-plasm. Mendelian phenomena are of secondary importance, and result from the permutations and combinations of these different samples of germ-plasm, or of the so-called factors contained therein, in the process of amphimixis.

Prof. Hickson said that the evidence that the chromosomes are the sole bearers of hereditary characters is not proved, and for many reasons is not probable. That the cytoplasm is the sole bearer of such characters is also not proved, and is still more improbable. The only proposition that is proved is that the hereditary characters are transmitted by the sexual cells as a whole, and that the characters are formed by the interaction of nucleoplasm and cytoplasm. He held that there is very strong evidence for the belief that the act of fertilisation involves a conjugation of nucleoplasm with nucleoplasm and cytoplasm with cytoplasm, and that the mixing of both these plasms is essential for the process.

Prof. M. Hartog, in referring to the statement that the sperm introduced only chromoplasm into the egg, pointed out that Vejdovsky had shown in the clearest way in Rhynchelmis, which by the size of the plasmatic elements concerned afforded the best material for such study, that the middle piece of the sperm was not merely a centrosome, for on entrance into the egg it enlarges enormously into a mass of reticulate cytoplasm. This mass sends out radiating strands, which feed on the yolk-granules, and so nourish the enlarging mass within which the centrosome is formed about the centriole.

In reply Prof. MacBride said it was true, as Prof. Dendy had remarked, that the fate of a germ-cell depended not only on its nature but on its environment. But when the environment was altered a new type was not produced, but merely a modified edition of the old type. He could not accept Prof. Hartog's view that the middle piece of the spermatozoon constituted an important addition to the cytoplasm of the egg, for if that were so, when a cross was made between two distinct species, the paternal characters should appear in the earliest stage of development, which was not the case.

Material Collected in Australia or en route thereto.

The greater portion of the meeting on the Friday morning was devoted to four papers dealing with material collected in or *en route* to Australia last year. Prof. Herdman gave a short account of work by himself and Mr. Andrew Scott on the plankton collected during traverses of the great oceans. The material was collected by letting the sea-water, which is pumped continuously into the ship, flow out from a bath- or other tap through a fine-meshed silk net. The net was changed morning and evening, so that each sample obtained represented a twelve hours' catch. The amount of plankton per haul dropped markedly in passing from coastal to oceanic waters. Prof. Herdman referred to a number of the more interesting organisms obtained. He remarked that on the day after leaving the Cape the sea was blood-red in colour, and highly luminous at night. The gatherings then taken were found to contain large numbers of a small red Peridinean, which was probably the cause of both the colour and the luminosity.

Dr. J. H. Ashworth described larvæ of Lingula and Pelagodiscus (Discinisca), which were collected by the method above-named. The seventeen larvæ of Lingula obtained in the southern portion of the Red Sea and off Ceylon varied in diameter from 0·5 to 1·6 mm. In the smallest there was no trace of peduncle, but in the largest this organ was well formed, glandular at its tip, and ready to be extended to fix the animal to the substratum. The shell-valves of all the specimens were transparent, and in the case of the youngest specimens were still connected together posteriorly by a thin film of chitinoid substance forming a hinge. The cirri, alimentary canal, statocysts, and cœlomoducts were briefly described. Six larvæ of Pelagodiscus were taken a few miles west of Cape Comorin, and were examined alive. They were all about the

same stage, having four pairs of cirri. The chief anatomical features were demonstrated, and attention was directed to the fact that the stalk of these two Brachiopods develops as an outgrowth from the ventral mantle, whereas that of cardinate Brachiopods (*e.g.* Terebratulina) is formed at a much earlier stage from the entire posterior region of the larva.

Prof. Dendy exhibited and commented upon a series of specimens collected in Australia, among which were certain rare sponges, land planarians, land nemerteans, and three species of Peripatus. The sponge fauna of Tasmania in particular proved to be extremely rich.

Prof. Poulton exhibited a Buprestid beetle, and seven species of bees taken on Eucalyptus. The bees represented five genera but were closely similar in appearance.

The Discession of the Chromosomes.

Prof. M. Hartog has re-investigated the discession of the chromosomes in cell-division, and described a series of physical experiments illustrating the path of the chromosomes. Their motion is in accordance with the theory that the chromosomes behave as "flexible inductors" in the cell-field, which is not a uniform field, as it is traversed by the spindle-fibres, stretching from pole to pole along the lines of force, the distribution of which they modify.

Purpose and Intelligence in the Protozoa.

Mr. Heron-Allen sought to make clear the position which he has taken up in regard to the theory and phenomena of purpose and intelligence in the Protozoa, as illustrated by selection and behaviour in the Foraminifera. He held (1) that every living organism, having an independent existence, is endowed with that measure and quality of the faculties of purpose and intelligence which are adapted to and called forth by the individual needs of that organism; (2) that these faculties are illustrated by the utilisation by the Foraminifera of foreign substances selected by the animal from a heterogeneous mass of environmental material, and utilised in such a manner as to provide the animal with means of adaptation to its special environment and defence against its special enemies; (3) that it is not competent for a consistent evolutionist to postulate a break in the evolutionary cycle for the introduction at some arbitrary point of an influence of unknown origin, to which he gives the name of intelligence, upon which purpose depends; and (4) that the phenomena under discussion are not to be confounded with adaptations or tropisms.

Recent Work on Pennatulacea.

Prof. Hickson gave a short account of some of the results of his investigation of the rich collection, amounting to 550 specimens, of Pennatulacea made by the *Siboga* Expedition in the Malay Archipelago. This area has proved to be extraordinarily rich in sea-pens, no fewer than seventeen of the thirty-two recognised genera being represented in the collection. Of particular interest is the presence of Gyrophyllum, hitherto found only in deep water in the Atlantic, and of Chunella, hitherto found only off the coast of East Africa.

The Metamorphosis of Bilharzia.

Lieut.-Col. R. T. Leiper communicated some results of his recent work in Egypt on Bilharzia, a Trematode parasitic in man, and found when adult in pairs in the portal vein and neighbouring abdominal veins. He pointed out that the predominant theory regarding the transmission and metamorphosis of this worm is that put forward by Looss in 1894. Looss believed that there was no intermediate host; that the freshly-hatched larva (miracidium) entered man only through the skin, undergoing metamorphosis in the liver; and that the vesical and intestinal lesions caused respectively by terminal and laterally spined eggs were caused by the same species, the lateral-spined eggs being parthenogenetically produced. Dr. Leiper has succeeded in producing heavy infections of rats, mice, guinea-pigs, and monkeys with cercariæ discharged from *Planorbis boissyi*, one of the commonest of Egyptian fresh-water molluscs. The miracidium enters this Planorbis and undergoes metamorphosis in the liver, forming primary and secondary sporocysts, which give rise to bifid-tailed cercariæ. Infection was found to take place through the skin, and also through the mucous membrane of the mouth and œsophagus when water containing large numbers of cercariæ was drunk. Lateral-spined eggs were produced by paired worms, and there was some evidence, not yet fully examined, that the vesical and intestinal lesions were caused by distinct varieties or species of Bilharzia.

The Relation of the Phylogeny of the Parasite to that of the Host.

Mr. L. Harrison advanced the proposition that, in the case of total obligate parasites, closely related parasites will be found to occur upon phyletically-connected hosts without regard to other œcological conditions. As the state of evolution of the parasite will be less advanced than that of the host, it follows as a corollary that a study of such parasites may give valuable indications as to host phylogeny. He based his arguments largely upon his study of conditions in the Mallophaga, which are found among and feed upon the feathers of birds. Mr. Harrison finds that, in general, the Mallophaga parasitic on any avian order are recognisable at sight, and in many cases it is possible to state definitely that a parasite has come from a particular family of birds. Thus *Philopterus lari* occurs upon all gulls, *Lipeurus anatis* upon all ducks, *L. columbae* upon all pigeons, and species of Tetrophthalmus occur on all pelicans, in the gular pouch, and are all similarly modified in their treacheal system in accordance with the conditions. The only reasonable explanation is that the parasites have had common origin. If this be the case, the Mallophaga may afford valuable evidence as to the relationships of birds, and Mr. Harrison brought forward strong circumstantial evidence from the Mallophaga to indicate that Apteryx is not a Ratite related to the ostrich, rhea, etc., but is a Ralline bird.

Dr. Gadow remarked that on anatomical grounds the rails were believed to be the nearest relatives of Apteryx, and that in this case he agreed with Mr. Harrison's conclusions, but he could not accept Mr. Harrison's suggestions in regard to other relationships, *e.g.* of the penguins and pigeons.

The Genus Eronia.

Dr. F. A. Dixey said that the Eronia, a genus of Old World Pierine butterflies, might be divided into three subgenera: (1) Nepheronia, from Asia and Mayalan islands; the females have a likeness to various species of Danainæ. (2) Leuceronia, from Africa and Arabia; three of the species have polymorphic females which copy some other butterfly belonging to the Pierine subfamily, but of no close affinity with Leuceronia. (3) Eronia proper, two species from Africa; in both species the underside is coloured like a dead leaf. The likenesses noticed in the first and second groups can scarcely be due to affinity, and since some of the forms resembled by the Eronias are known experimentally (and others are believed on good grounds) to be more or less distasteful to insectivorous animals, Dr. Dixey considered

that the theory of mimicry appeared to offer the most feasible interpretation of the conditions obtaining in this genus.

Geological Changes and the Distribution of Fish.

Prof. A. Meek exhibited lantern slides of maps illustrating Tertiary changes and their relation to the distribution of fish. He said that from geological evidence it was known that during the Tertiary era the northern hemisphere was the scene of important changes affecting the sea and the land. A consideration of the distribution of marine and fresh-water fish bears out this evidence, indicates the refuge regions of the Glacial epoch, and shows that the reaction of changing conditions has during the era led to the formation of many species (*e.g.* those of Acipenser) and even of genera (*e.g.* Caspiomyzon). The fish of the Antarctic seas appear to be northern in origin, but the fresh-water fish-fauna of the southern hemisphere is characterised by the presence of primitive types, which appear to have survived from the period of Gondwanaland and the spread of the Glossopteris flora.

Regeneration of the Tail in the Lizard.

Dr. C. Powell White gave an account of the regeneration of the tail of *Lacerta vivipara*. Autotomy of the tail takes place through the middle of a vertebra; there is no special autotomy site as in the legs of crabs, but apparently any vertebra may be involved. After autotomy the wound is quickly covered with new skin, beneath which is a mass of spindle cells, originating in the connective-tissue, which acts as a growing point to the new tail, and from it the cartilage, fat, muscles, and vessels are developed and differentiated. All the nerves are derived from the last three pairs of nerve-roots in the stump of the tail. The main trunks of the sympathetic accompany the aorta some distance into the regenerated tail and send branches to the different blood-vessels. In the centre of the tail is an unsegmented tube of cartilage (perforated by blood-vessels which pass to the interior) continuous with the body and neural arch of the vertebra through which the fracture took place. This cartilage surrounds an epithelial tube continuous with the central canal of the spinal cord. Regeneration may continue until the regenerated tail is as long as the original one.

The Vermiform Appendix.

Dr. W. C. Mackenzie demonstrated a fine series of specimens of the appendix vermiformis in Monotremes and Marsupials. He drew attention to the fact that Ornithorhynchus has a cæcum, while Echidna has a true vermiform appendix, comparable macroscopically and histologically to that of man, ape, and wombat, the three mammals regarded as having a true vermiform appendix. In Phascolomys the appendix has reached a much more advanced degree of degeneration than that of man, even to complete disappearance by incorporation in the wall of the ileum (various grades of this were shown), a condition suggestive of the mode of further evolution of the appendix in man.

An Explanation of Secondary Sex Characters.

Mr. F. W. Ash suggested that male secondary characters are characters of abandoned function suppressed in the young in favour of more essential growth (of organs still fully functional), and in the adult female because, with her, nutritive surplus is more directly diverted to the purposes of reproduction. Hence such characters usually find opportunity for full expression in adult males. Secondary sex exaggerations may significantly parallel enlargements due to accidental loss of function, *e.g.* the tusk of the male babirussa may be compared with occasional circular overgrowth in the tusk of the hippopotamus. The dependence of the development of the secondary character on the presence of the active male gonad may perhaps be explained by reference to the phenomena of periodicity.

History of Comparative Anatomy.

Prof. F. J. Cole and Miss N. B. Eales presented materials for a graphic history of comparative anatomy based on an examination of 6304 papers on the anatomy of animals published between 1543 and 1860. The graphs exhibited show that before the year 1650 only intermittent research was carried on, but in the next fifty years there was considerable activity, culminating at about 1683, and thereafter subsiding. This sudden revival was due almost exclusively to Academia Naturæ Curiosorum (founded 1652), the Royal Society of London (1660), the French Academy of Science (1666), and, to a less extent, the Collegium Anatomicum of Amsterdam (1665). From 1700 to 1750 work was steadily maintained, and a second revival began in 1750, gradually increasing to 1800, and suddenly reaching a high maximum between 1835 and 1840, finally declining somewhat to 1860, where the investigation ceases. The second revival was initiated by France, followed closely by Germany, and at some distance by England, but the last country reached her maximum first, then Germany, and finally France. Holland and Denmark took a distinct part in the seventeenth-century revival, and Italy was undoubtedly concerned in initiating the similar movement in the nineteenth century. The seventeenth-century revival related chiefly to mammals, but concerned to a less extent birds, fishes, and arthropods, and to a slight extent reptiles and molluscs. In the nineteenth-century revival, mammals, arthropods, fishes, and organography play the leading part, followed by birds, molluscs, and reptiles.

Dr. J. Stuart Thomson gave an account of the morphology of the telencephalon of Spinax as a type of Elasmobranch fore-brain, and detailed the various grey masses and fibre-tracts which he had recognised. He has not obtained any satisfactory evidence of the existence of a *corpus callosum*.

Dr. A. E. Cameron described the insect community of a local environmental complex. A soil-insect census of two different grasslands in the association, differing in their soil-types and vegetational covering, showed that in any given locality the soil-insect fauna of grassland is not likely to vary to any great extent. In the absence of the illustrations these two communications cannot be adequately summarised.

On the Thursday afternoon the members of the Section were received by Prof. and Mrs. Hickson in the Zoological Laboratories, where there was an interesting and extensive exhibit of specimens by members of the staff and by visiting zoologists.

J. H. ASHWORTH.

EDUCATION AT THE BRITISH ASSOCIATION.

As women are playing an ever-increasing part in the national work of education, it was an eminently reasonable departure from precedent for the council of the Association to elect Mrs. Sidgwick to the presidency of Section L. The full text of her address has already appeared in NATURE, and need not, therefore, detain us here, except in so far as it gave an opportunity to Lord Bryce to dot the "i's" and cross the "t's" of what was, in fact, an extremely sane pronouncement. Those who heard him will not

soon forget the vigour with which he associated himself with every word which the president had used. The confusion between education and book-learning, the fool's paradise in which modern democracies were apt to live when dealing with education and votes, the want of intellectual curiosity in England, a lament for the increasing disuse of the Bible—these were the main points, apart from some interesting personal reminiscences, of an unexpected but most welcome intervention.

Following the address came a series of papers on the "Methods and Content of History Teaching in Schools." Prof. F. J. C. Hearnshaw, after a pointed reference to the education section as the happy hunting-ground of the amateur, dealt in the main with the purpose of historical teaching. The aim of education seemed to him less simple than of old. There are no heroic figures typifying the national or religious ideal—a Leonidas, a Pericles, a St. Thomas Aquinas—such as had given unity to educational effort in the past. Instead of that, we talk of technical, or intellectual, or moral training, emphasising the individual and losing sight of the civic aspect. The current appeals to self-interest, upon which sections of our countrymen were basing anti-political organisations, showed how much British democracy was in need of mental and moral salvation.

History in its right place would do much in this direction. The subject has greatly altered in its methods and aims. Its procedure is now scientific. It seeks for laws. It is the memory of the race, and as such the finest school for statesmen. From the civic viewpoint its purpose is threefold, as the subject is at once a school of political method, a storehouse of political precedents, and a basis of political progress. To serve such a purpose it must be wider and more empirical in treatment. Prof. Ramsay Muir regarded intensive work on a special period as essential to the study of history. It was just this intensive work which gave force to the old classical training, and which helps it still to hold its own. But though the intellectual gain from history could only come in this way, the intensive study of a period must have a background which would make the world of to-day intelligible. Such a background was best found in the unique character of British empire history and the development of self-government in the last four centuries. Dr. E. O. Morris protested strongly against the views of Prof. Ramsay Muir, which neglected entirely the working conditions of the schoolmaster who has to deal, not with the cream of creation who become professors, but with the average boy who has to present eight subjects in an examination, failure in any one of which means failure in the whole. He urged the abandonment of the rigid division between English, history, and geography. Until examination systems were reformed, no useful suggestions can be made unless they are on examination lines. Mr. J. A. White dealt with the problem from the point of view of the elementary school. Any scheme should be based on three fundamental principles: the matter must appeal to the pupils, development must be its cardinal feature, and it must explain modern conditions. Prof. T. F. Tout opened the discussion by expressing serious disagreement with some of the papers. He did not share the dark views of democracy held by Prof. Hearnshaw. Unfortunate as was the South Wales strike, it was not so bad as the mutiny of the Nore, and the corruption of the Whigs and Tories of the eighteenth century was colossal as compared with the mild corruption and amateur log-rolling of to-day. Prof. Ramsay Muir seemed to see his own subject in false perspective—the ordinary vice of the specialist. Whilst agreeing with him in his condemnation of constitutional history and of economic history as school studies, he was altogether out of sympathy with his idea of beginning history with the Reformation. Such a course would leave out of English history the study of all those forces which gave the England of to-day its special character. He referred sympathetically to the special difficulties of the schoolmaster, and incidentally expressed his belief that the good schoolteacher of history need not be in any sense a specialist on the subject. Sympathy and intelligence are more important than special knowledge.

Miss E. E. C. Jones read a paper on the teaching of ethics and politics, which had to be cut short before it reached the practical problems involved, and the first day's proceedings were brought to an end by a stimulating paper from Prof. R. S. Conway, who was concerned lest literary, and especially classical, teaching should suffer from the stimulus to technical and scientific education which would come from the war. The Prussian *Realschulen* taught the German youth how to build strategic railways, but not how to find his way to the affections of alien subjects.

The second day was given up to "Military Training in Schools." Dr. A. A. David pointed out the difference between the cadet training of to-day and the old military drill of the sergeant-instructor. The latter system was never taken seriously either by masters or boys. The drill was usually bad, and bad drill is worse than no drill. The new opportunities have completely transformed many boys who especially appreciate the greatly increased chances of leadership. The work had, moreover, a bracing effect on the whole school. Mr. J. L. Paton entirely dissented from the headmaster of Rugby on the general question of the desirability of military training in school. He felt this a particularly bad time for its discussion. The emancipation from the drill-sergeant was no substitute for physical exercises and games. The strategic point of education is adolescence, and co-operation, not struggle, is the keynote of progress. Lancashire, he was sure, would have nothing to do with a system which means officers from public schools and privates from elementary schools. Compulsion in patches was undesirable. The hope of the future lay in federation and international co-operation. This movement means we are to shut our eyes to social consequences and to turn the nation into a barracks. War, like all other forms of evil, was only temporary. Mr. A. A. Somerville strongly disagreed with Mr. Paton. The object of the movement was not to train for war, but to enable the future citizen to defend his home and its development, and, above all, the justification for it lay in its educational possibilities—in cultivating the powers of leadership, of taking initiative, qualities of vast import to the empire. The O.T.C. has provided 30,000 officers for the present war. There was no thought of compulsion in the schools. Mr. Wood dealt with the facts of the position in the colonies and in western Europe. Prof. Hearnshaw, Prof. Boyd Dawkins, Mr. Roper, Prof. Findlay, Rev. W. J. Barton, and Mr. Richardson took part in the subsequent discussion.

The third day's discussion on the "Education of Girls with Special Reference to their Careers" was perhaps the best of the series. There was a large audience of people who were evidently keenly interested in the question, and all the papers reached a high level both as to matter and mode of delivery. Mrs. W. L. Courtney divided the possible occupations for girls into three groups:—(*a*) Those requiring university training, *e.g.* medicine, teaching, and the like. The requirements of the university must in these cases determine the curriculum. (*b*) Nursing, social work, and public health service. School can do nothing special here. A sound general education

and good health were the prime requisites, though school might do more to awaken girls' interest in public questions. (c) Occupations which can be begun at an earlier age, *e.g.* secretarial and clerical work—journalism, accountancy, and civil service. Two views as to this class of girl. Either she should leave school at fifteen and go to a "crammer's," or the school should organise special courses. But school-trained girls are not wanted by business men. They find the school training rather "amateur," and in any case the atmosphere of school, when it is right, is not that of business. Six months or a year in a reorganised business school is a desirable interlude. Civil service ought not to encourage competitive examinations before sixteen, and so cut short the proper school time of a girl. Miss Haldane also opposed all utilitarian claims upon school. A better education of a general kind is what is wanted. The want of prospects under which most girls had to do their work and the narrow specialisation of the preparation for Government work had a most depressing influence. "We cannot afford to be economical in the matter of education. If school buildings must be plain, at least we must see to it that the staff is well-qualified and efficient." Miss Oldham pointed out the increased necessity for training women for economical independence. "What strengthens women in the best sense strengthens the nation." She urged free entry and free progress for women into all professions for which they are physically fit, an improved status for the home-maker, who should have a right to the best education and to the honour and rewards which belong to great tasks well discharged. "Motherhood is so important that a whole year might well be given to its problems in the education of every girl. Even for those who never marry, it should be remembered that the preservation of babies born is the first line of defence of our sex." Miss Charlesworth, "a voice from the bottom," as she expressed it, spoke from the clerk's point of view. The most important thing in the education of a girl is to develop "self-reliance and independence"—much more important than technicalities. A girl with this feeling will not do a woman's work for 12*s*. 6*d*. a week "if only it is genteel." School should teach girls not to take work without prospects. Girls are very apt to mistake permanence of employment for a career. Some standardisation for the education of clerks was a great need in these days. Miss Burstall, Miss Escott, Miss Foxley, Miss Sheavyn, Miss Higgs, and Mrs. Findlay took part in a very lively discussion. Miss Burstall was severely criticised for the view that Latin should be left to the *clever* girls—an expression which probably did not mean to its author what it suggested to her audience.

The section met again on Saturday morning. The large gathering was significant of the interest taken in the subject—education and industry. Sir William Mather declared that the two were connected as intimately as soul and body. Future historians will marvel at the fact that we made no attempt whatever between 1872 and 1889 to deal with technical education, and that until quite recently we gave more time and energy to quarrelling about the place of religion in education than to the problem of how to make our boys and girls "children of light." After paying a warm tribute to the work of the City and Guilds Institute, he pointed to the waste of elementary educational expenditure, because of the absence of any general form of continued schooling. Happily, Great Britain was a peculiarly plastic country. It learned best from its own mistakes, and herein lay the hope of the future. Such voluntary movements as that of the boy scouts had much to teach us. Mr. Maxwell Garnett pointed out the great gulf fixed between education and industry. We have thought out the material and equipment side of education much in advance of the human. The scientific way of handling educational problems was much handicapped by the want of a technical language. The use of the words of ordinary life was productive of all kinds of misconceptions. Education should aim at developing a single wide interest. The old notion of a general education was psychologically absurd. Coherence at seventeen is the surest way to comprehensiveness at twenty-seven. By means of a chart, Mr. Garnett showed what should in his view be the relation of each grade of education to the rest. Mr. J. Graham described the practice of the Leeds authority in providing a quasi-technical training for boys about to leave the elementary school. The work began in two or three so-called "Day Preparatory Trade Schools," in which the time-table was divided into three broad sections dealing about equally with English, drawing, and manual work. Now it is proposed to extend this provision to all the elementary schools of the city. On leaving the school, the boys enter a trade, and a real technical education should begin, lasting for four years (fourteen to eighteen), and occupying half the pupil's time. In the secondary schools the vocational claim is being admitted. The matriculation examination should be broadened. The present dominating influence of the university upon the schools should be weakened, but the secondary schools ought not to be made into technical schools. The president of the Association pleaded for practical suggestion. He did not think our present system was wrong because it turned out too few trained minds. Incidentally he criticised the use of the term "Honours" in the universities. Principal Griffiths raised the question of education in its relation to want of understanding between employers and employed, not a little, he thought, due to such "class" education as that of Ruskin College. The discussion closed with some account of the educational work done by the Westinghouse Co. for its younger employees.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The fifth edition of the War List of the University was published by the *Cambridge Review* on November 15, and is an impressive quarto volume. It consists of 90 pp. and cover, and contains more than 11,000 names. Trinity College has 2500; Pembroke 1052, Gonville and Caius 952; Clare 750; Emmanuel 648; Trinity Hall 603; Jesus 559; King's 556; Christ's 540; and St. John's 513. The other colleges also show a great increase in numbers. The list not only contains the names of past and present members of the University who are serving in every branch of both Services, but, so far as is known, after each name appears the honours awarded for distinguished service; also, alas! the large number of both killed and wounded. It is a record of which the University may well be proud, showing, as it does, Cambridge University's fine spirit. There are 614 killed, nearly 900 wounded, and 123 prisoners and missing. The distinctions comprise:—Mentioned in Despatches, 241; V.C., 3; D.S.C., 1; D.S.O., 36; Military Cross, 48; D.C.M., 4; K.C.B., 1; C.B., 2; C.M.G., 6; Medaille Militaire, 4; Croix de Chevalier, 10; Croix de Guerre, 4; Russian Orders, 5; Serbian Order, 1.

THE Long Fox lecture will be delivered by Dr. Richardson Cross, at the University of Bristol, on Wednesday, December 1. The subject will be "The Evolution of the Sense of Sight."

A VERY useful summary of the recent literature bearing on the application of psychology to problems of childhood and adolescence is given in the *Psychological Bulletin* (vol. xii., No. 10). In a summary it is difficult to note any one section in particular, but in view of its extreme importance both to educationists and social workers of all grades, the work of Woolley and Fischer in a mongraph entitled "Mental and Physical Measurements of Working Children" is important. As a result of an investigation of 800 working children they found that about 85 per cent. were retarded at the age of fifteen in height, weight, lung capacity, and the mental processes of memory and reasoning. Such studies giving evidence of the detrimental effect of a particular environment ought not to pass unnoticed.

FROM the issue of *Science* for October 15 last we learn that Mr. J. H. Schiff, a member of the board of trustees of Barnard College and its first treasurer, has given 100,000*l.* to the college for a woman's building. The University of California has received 20,000*l.* from an anonymous donor to endow the "Dr. C. W. and Mrs. Fox Memorial Beds" in the University of California Hospital. The beds are to be maintained in the new University Hospital, now being erected in San Francisco through the gift of 123,000*l.* by friends of the University. The superior court of San Francisco has just decided in favour of the University a suit for 29,000*l.* brought by the regents against the heirs of the late Mr. J. M. Keith, who had refused to pay the balance of 29,000*l.* due under a subscription made toward this new hospital by Mr. Keith, of which but 1000*l.* had been called for at the time of his death. The will of the late Anna Yarnall creates a trust fund of 5000*l.*, which is placed in the hands of the trustees of the University of Pennsylvania for the support of the botanic gardens of that institution.

THE recently issued report of the University of Leeds provides a noteworthy example of the scientific assistance which the universities have been able to give in the prosecution of the war. In August, 1914, at the instance of the Board of Agriculture and Fisheries, the Agricultural Department of the University prepared a handbill of suggestions for the management of gardens, allotments, and poultry, for the guidance of the population of Yorkshire, to enable the best use to be made of the remaining weeks of the summer in increasing the stock of food stuffs. This handbill was distributed throughout the three Ridings of Yorkshire. When the Government appointed a Chemical Trades Committee to investigate the question of dyestuffs and of explosives, the resources of the Department of Tinctorial Chemistry and Dyeing, founded by the munificence of the Clothworkers' Company, were placed at the disposal of the Committee. The Textile Department was able to render service in testing the strength and elasticity of cloths made for army contracts, and to advise members of the textile trades as to the methods of producing special fabrics hitherto manufactured in Germany. The Departments of Chemistry have been engaged in the preparation of products needed for the medical treatment of wounded soldiers, and experimental research has been carried out in connection with the treatment of those suffering from gaseous gangrene. Experiments have been made in the University laboratories to devise means of protection for the troops against poisonous gases. The staff of the Engineering Department, with the help of the Department of Physics, have been engaged in special work in connection with the war, and the resources of the laboratories have been placed at the disposal of the authorities for this purpose. And all this has been in addition to the noble work done by the Medical Department and the provision of 917 men for the Forces of the Crown.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 11.—Sir William Crookes, president, in the chair.—Sir Ronald **Ross**: Studies on *a priori* pathometry.—Part i. The object of these studies is to determine the nature of the functions according to which the number of individuals infected with some disease should vary from time to time, on the supposition that the laws governing the rate of transference of the considered disease are already known *a priori*; and it is hoped that a future comparison of the curves so obtained, with the numerous statistical curves of epidemics already on record, will enable us to check the accuracy of the said *a priori* suppositions and to obtain light on the causes of the rise and fall of epidemics. The fundamental problem under consideration is the following:—If a population is divided into two groups, namely, those who are affected by some kind of happening, such as an infectious disease, and those who are not so affected; and if in unit of time a constant or variable proportion of the non-affected become affected, while simultaneously, a constant proportion of the affected become non-affected (that is, revert or recover); and if at the same time both the affected and the non-affected are subject to different birth-rates, death-rates, and rates of immigration and of emigration, so that the whole population may be incessantly varying during the period under consideration; then what will be the number of affected individuals and also the number of new cases at any moment during that period?—J. **Barcroft** and T. **Kato**: Effects of function activity in striated muscle and the submaxillary gland.—W. L. **Balls** and F. S. **Holton**: Analyses of agricultural yield. Part ii.—The sowing-date experiment with Egyptian cotton, 1913.—H. H. **Thomas**: Williamsoniella, a new type of Bennettitalean flower.—T. **Lewis**: The spread of the excitatory process in the vertebrate heart. Part i.—The toad's ventricle. Part ii.—The tortoise ventricle. Part iii.—The dog's ventricle. Part iv.—The human ventricle. Part v.—The bird's heart.

Faraday Society, October 19.—Sir Robert Hadfield, president, in the chair.—F. **Powis**: The transference of electricity by colloidal particles. An attempt is made to calculate the charge carried by the particles of a colloidal solution produced by sparking (1) from a modification of Stokes's formula, (2) from the increase in conductivity on making the solution. The second method gives a value much greater than the first. Anions and kations are adsorbed in such a way that the concentration of each gradually decreases with increasing distance from the particle, until each finally becomes equal to that in the bulk of the surrounding medium.—F. H. **Jeffery**: Electrolysis of (*a*) nitric acid, (*b*) sulphuric acid, (*c*) orthophosphoric acid, using a gold anode. The platinum kathode was enclosed in a porous pot and the acid used for katholyte was of the same concentration as that used for anolyte. In all cases the soluble gold compounds formed contained the gold as complex anion; no gold was deposited on the kathode.—J. H. **Jeffery**: Electrolysis of concentrated hydrochloric acid using a copper anode. The platinum kathode was enclosed in a porous pot, and all experiments were performed in nitrogen or carbon dioxide. The copper dissolved in the cuprous condition and as complex anion alone, there being no deposit of copper on the kathode. No chlorine was evolved at the anode.—W. **Clayton**: The thermal decomposition of hydrogen peroxide in aqueous solution. Preliminary note. The rate of thermal decomposition of aqueous solutions of hydrogen peroxide is extremely

sensitive towards extraneous organic matter in the colloidal state. In tap-water the rate of decomposition is fully fifty times that in the purest specimen of water yet prepared. Previous work upon the thermal decomposition of H_2O_2, especially the comprehensive research of Lemoine, must be considered as of doubtful value, as no special precautions appear to have been taken.

Physical Society, October 22.—Dr. A. Russell, vice-president, in the chair.—Dr. T. **Barratt**: The radiation and convection from a heated wire in an enclosure of air. The object was to determine the numerical relation between the radiation and the convection losses from a heated metallic wire or rod placed in a gas at constant temperature. The method consisted in (1) measuring the amount of heat required to maintain the temperature of the wire a given amount (about 10° C.) above that of the surrounding gas, the surface of the wire being (*a*) coated with a dead-black varnish, (*b*) uncoated, (2) comparing the radiations from two surfaces exactly similar to (*a*) and (*b*) by means of a thermopile. If the total heat lost from unit surface of the wire is *a* times greater from a "black" wire than from a "bare" one, while the radiation from the black surface is *b* times more than from the unblacked surface, then

$$\frac{r_2}{c}=\frac{a-b}{a-1}, \text{ and } \frac{r_1}{c}=\frac{b(a-b)}{a-1},$$

where r_2, r_1 are the radiations from "black" and "bare" surfaces respectively, and c is the convection. Of 100 parts of "total heat" lost from a wire at air temperatures, 2·5 consist of radiation for a bare wire, and 12·6 for a "black" wire. At 100° C., these percentages become 4·4 and 20·7 respectively.—Dr. A. **Griffiths**: The determination, by the method of diffusive convection, of the coefficient of diffusion of a salt dissolved in water. The diffusion of matter, like the diffusion of heat, produces convective currents, and there is a diffusive convection akin to thermal convection. In the apparatus described the convective flow is of the order of one millionth of a cubic centimetre per second from the top of one set of diffusion tubes to the top of another set. The top of each set of diffusion tubes is enclosed in a glass vessel containing water, and one vessel is connected to the other by means of a long capillary tube. Each set of eight diffusion tubes is of length about 5 cm., and has a total area of cross-section of about 0·5 sq. cm. The capillary tube is about 150 cm. long, and has a diameter of about 1 mm.; and the linear flow of a coloured index, consisting of a feeble solution of uranine, is of the order of 10 cm. per day. The index is introduced by means of a special four-way glass tap. Dr. T. **Barratt**: The magnitude of the thermal resistance introduced at the slightly conical junction of two solids and its variation with the nature of the surfaces in contact. The abrupt fall of temperature caused by the thermal resistance at the slightly conical junction of two solids has been examined, the method consisting in constructing a "double joint," thus doubling also the thermal resistance effect. In wires of small diameter, the fall of temperature was found to be 2¼ per cent. This percentage fall of temperature is practically the same at all temperatures of the enclosure (up to 100° C.), and is independent of the excess of temperature of the end of the wire above that of the enclosure (at any rate, up to 10° C. or 12° C.). For wires of greater diameter (6 mm.) the resistance is rather less than for smaller wires.

Zoological Society, October 26.—Prof. E. W. MacBride, vice-president, in the chair.—E. G. **Boulenger**: The feeding of snakes in captivity. The results showed that, with rare exceptions, snakes that refused to feed on dead animals were not more likely to accept them if alive.—Dr. S. F. **Harmer**: Specimens of Cuvier's whale (*Ziphius cavirostris*) from the Irish coast. The inclusion of *Z. cavirostris* in lists of the Cetacea of the British seas appears to rest on the evidence of a single skull obtained by Sir William Turner from Shetland. By an arrangement made with the Board of Trade in 1912, the British Museum receives telegraphic reports of the stranding of Cetacea on the British coasts. Two of the specimens thus reported have proved to belong to this rare species, and their skeletons have been secured for the museum. —Dr. F. E. **Beddard**: *Taenia struthionis*, Parona, and allied forms. A probably new species of Davainea, parasitic in the ostrich (*Struthio masaicus*), was defined.—Prof. S. J. **Hickson**: Some Alcyonaria and a Stylaster from the west coast of North America. Three new species of Alcyonaria were described.

Linnean Society, November 4.—Prof. E. B. Poulton, president, in the chair.—E. **Heron-Allen** and A. **Earland**: The Foraminifera of the west of Scotland, collected by Prof. W. A. Herdman, on board the s.y. *Runa*, 1913. The authors directed attention to the richness of the material, which on examination had yielded nearly 330 species and varieties, among which two species and several varieties are new to science. About thirty species are new to Britain, whilst many are recorded for the second time only. Several of the species recorded in the authors' Clare Island monograph as new to science, or to Britain, are included in the latter category. The material consisted of shore-gatherings and comparatively shallow-water dredgings, containing few shells or stones, which accounts for the comparative absence of many adherent and deep-water forms which are normally found in these waters.

Society of Public Analysts, November 3.—Mr. A. Chaston Chapman, president, in the chair.—W. H. **Simmons**: Formic acid as a reagent in essential oil analysis. Continuing his work on the determination of citronellol in geranium oils by formylation ("Year-Book of Pharmacy, 1913"), the author has examined fifty further samples of Bourbon geranium oil, including most of the more important brands, and finds them to contain 45 to 57 per cent. of citronellol, while another ten samples of African geranium oil gave only 32 to 43 per cent., thus confirming the previous results. Experiments on the formylation of various essential oils and their alcoholic constituents show that turpineol is almost completely decomposed by the process; geraniol and linalool are both converted into an appreciable quantity of ester; santalol is only very partially decomposed, and citronellol, menthol, and the borneol in rosemary oil may be approximately estimated by the process.—H. L. **Smith**: The melting point of salicylic acid and a test for the presence of para-hydroxybenzoic acid. The melting point of carefully purified salicylic acid after drying over sulphuric acid is 158·5° C. The presence of small amounts of para-hydroxybenzoic acid appreciably lowers the melting point. The crystalline forms of the acids are different, and the presence of para-hydroxybenzoic acid may be detected by means of the microscope.—E. **Hinks**: The persistence of hydrogen peroxide in milk. Experimental results were given showing that unqualified statements as to the length of time during which hydrogen peroxide will persist in milk are of no value. The length of time depends upon the age and condition of the milk. In a case in which peroxide was added to a perfectly fresh milk in the proportion of 0·2 per cent., it was still present in estimable proportion after the lapse

of eighteen months. It was found that within the range of from 15° to 37° C. the higher the temperature the longer did the peroxide persist.

Geological Society, November 3.—Dr. A. Smith Woodward, president, in the chair.—Dr. C. W. **Andrews**: Discovery and excavation of a very large specimen of *Elephas antiquus* near Chatham. The specimen was originally discovered about three years ago by a party of sappers who were digging a trench. The extraction of the bones was delayed until the past summer. A great part of the skeleton has now been collected. The skull, unfortunately, was in a very bad condition, but two complete upper and one lower second molars were obtained. One tusk, from 7 to 8 ft. long, was also found. The lower ends of both femora were destroyed in the original trench, but of the other limb-bones, nearly complete specimens from one or both sides have been obtained, as well as a sufficiently large series of bones of the feet to allow of their reconstruction. Many vertebræ were also collected. The animal, which was adult, must have been of very large size, having stood about 15 ft. at the highest part of the back, or more than 3½ ft. higher than the large African elephant mounted in the entrance hall of the Natural History Museum. The molar teeth show conclusively that the species represented is *Elephas antiquus*, and from the thickness of the enamel and some other characters it may be inferred that the animal was probably of a type as early as, or earlier than, that found at Grays. It is the first British example of this species in which the skeleton has been found directly associated with the teeth.—G. C. **Crick**: Two Nautili from the Upper Cretaceous rocks of Zululand.

Mathematical Society, November 11.—Sir Joseph Larmor, president, in the chair.—G. H. **Hardy**: (1) The second theorem of consistency for summable series. (2) Weierstrass's non-differentiable function.—F. B. **Pidduck**: The kinetic theory of the motion of ions in gases.—H. W. **Turnbull**: Some singularities of surfaces and their differential geometry.—Dr. J. W. **Campbell**: Periodic solutions of the problem of three bodies, in three dimensions.—C. R. **Dines**: Functions of positive type and related topics in general analysis.—C. H. **Yeaton**: Surfaces characterised by certain special properties of their directrix congruences.

Royal Astronomical Society, November 12.—Prof. R. A. Sampson, president, in the chair.—E. W. **Maunder**: magnetic disturbances, 1904–13, and their association with sun-spots. The results showed that there is a strong tendency for disturbances to recur when the same meridian returns to the centre of the sun's disc, that is to say, after an interval of a synodic rotation of the sun.—Rev. A. L. **Cortie**: The efficiency of sun-spots in relation to terrestrial magnetic disturbances. It appears that magnetic disturbances are relatively more numerous when the sun-spot area is decreasing than when increasing. The "efficiency" of sun-spots in relation to magnetic disturbances depends on the position of the spots, increasing with their approach to the solar equator.—H. H. **Turner**: Proposal for comparison of the magnitude scales of the Astrographic Catalogue. Eighth note: the Cape magnitudes for −42°.—A. R. **Hinks**: Some questions relating to the shape of the earth, suggested by Mr. Harold Jeffreys's paper, "Certain hypotheses as to the structure of the Earth and the Moon."—A. S. **Eddington**: The dynamics of a stellar system, being a third paper on the subject, dealing with oblate and other distributions.—F. **Henroteau**: Convection currents in high regions of the solar atmosphere.

CAMBRIDGE.

Philosophical Society, October 25.—Prof. Newall, president, in the chair.—R. **Hargreaves**: Examples illustrating the use of integral forms.—S. **Ramanujan**: A problem in the analytic theory of numbers.—C. E. **Weatherburn**: Vector integral equations and Gibbs's dyadics.—W. A. D. **Rudge**: A self-recording electrometer for atmospheric electricity. This instrument has been devised to record the changes in the value of the potential gradient. It consists essentially of a simple form of quadrant-electrometer, in which the motion of the needle is recorded photographically upon a strip of bromide paper. The whole apparatus is compact and can be constructed at a small cost. A number of records showing the changes in the potential due to the steam from trains, and to the dust raised from the roads by passing traffic are given.—J. **Reilly**: The resolution of asymmetric quinquevalent nitrogen compounds.

MANCHESTER.

Literary and Philosophical Society, October 19.—Prof. S. J. Hickson, president, in the chair.—C. L. **Barnes**: James Wolfenden, a Lancashire mathematician. In 1807 he calculated the first tide-table for the port of Liverpool.—W. C. **Jenkins**: Rainfall in Manchester during 1915. The amount of rainfall, measured at the Godlee Observatory, for the period commencing November last to October 18, was 31·856 in. The average amount for the last sixty years for the twelve months November to October was 32·820 in.—G. Elliot **Smith**: The evidence afforded by the winged-disc in Mexico and Central America for the Egyptian origin of certain elements of the pre-Columbian civilisation. The author had previously cited a very large series of curious customs and beliefs, built up into an artificial culture-complex, as a demonstration of the fact that the ancient civilisation of America was derived from the Old World. The proof is further corroborated by the study of various component elements. The distinctly Egyptian, and wholly arbitrary, association of the sun's disc with two serpents and hawk's wings is found represented on the lintel of the sanctuary in many ancient sun-temples in Mexico and Central America.—D. M. S. **Watson** and H. **Day**: Notes on some Palæozoic fishes. The authors described the structure of the head and of some other special regions in the Rhipidistian Crossopterygians, Holoptychius, Glyptopomus, Tristichopterus, Osteolepis, Gyroptychius, and Rhizodopsis, arriving at a presumptive Rhipidistian head. They then described the roof of the skull in the following Dipnoi:—*Dipterus valenciennesi*, *D. platycephalus*, *D. macropterus*, Scaumenacia, Phaneropleuron, Sagenodus, and Ceratodus. These fish in their order of appearance in time give a perfectly graded series, and obviously form an approximate phyletic-line, agreeing with that deduced by M. L. Dollo from a study of the unpaired fins. A study of the teeth supports the view that this series is a genuine one. The skull of *D. valenciennesi* is compared with that of a primitive Rhipidistian, and shown to agree with it bone for bone. It is also shown that both of these can be perfectly homologised with that of a Stegocephalian.

November 2.—Prof. S. J. Hickson, president, in the chair.—R. L. **Taylor**: Notes on hypochlorous acid and chlorine. A solution of an alkaline hypochlorite rapidly changes ordinary precipitated oxide of silver into black peroxide, closely approximating in composition to that represented by the formula Ag_2O_2. Comparison was made between the bleaching activities of hypochlorous acid and chlorine, the conclusion arrived at being that, contrary to the general opinion, the latter is considerably the more active of the two. The remarkable

effect of a very dilute solution of chlorine on litmus was shown. The litmus is at once turned a bright red colour, which rapidly changes back to purple, and then slowly bleaches. The author concludes that the usual explanation of the bleaching action of chlorine (in the case of litmus, at any rate) is not correct, but that the chlorine acts by directly chlorinating the colouring matter. Reference was made to the recent use of hypochlorous acid as the "ideal antiseptic." Prof. Lorrain Smith uses either a powder ("Eupad"), made by intimately mixing bleaching powder and boric acid, or a solution ("Eusol"), obtained by treating the powder with water. Both these mixtures will contain a considerable amount of hypochlorous acid, but also, inevitably, a certain amount of free chlorine. Dr. A. Carrell and Mr. H. Dakin recommend the use of bleaching powder mixed with boric acid and carbonate of lime; the last-named would have the effect of getting rid of most, if not all, of the free chlorine referred to above.

PARIS.

Academy of Sciences, November 8.—M. Ed. Perrier in the chair.—G. **Bigourdan**: The astronomical works of Peiresc. Details of work between 1635 and 1637.—A. **Blondel** and F. **Carbenay**: Oscillating systems with discontinuous damping. Application to galvanometers.—M. de **Séguier**: The transitive constituents of certain groups with bilinear or quadratic invariant in a Galois field.—M. **d'Ocagne**: The rectification and the quadrature of epi- and hypo-cycloids.—Nicolas **Kryloff**: A method of M. Boussinesq.—A. **Guillet**: Harmonic string siren. The measurement of Young's modulus.—L. **Tschugaeff** and W. **Lebedinski**: Two series of complex compounds derived from bivalent platinum and corresponding to the index of co-ordination 6.—Emile **Haug**: The tectonic of the Brignoles region.—A. **Guilliermond**: The origin of the anthocyanic pigments.—A. **Marie** and Léon **MacAuliffe**: General morphological characters of the insane. A statistical study of 100 cases shows that the insane present a morphology very different from the normal. The average height is low, but the limbs, especially the lower limbs, show a disproportional growth.—M. **Bonnefor**: The physiological trembling of the iris.—R. **Ledoux-Lebord** and M. **Dauvillier**: A new certain radioscopic method for detecting foreign bodies during surgical operations.—A. Ch. **Hollande**: Vital coloration by "soluble carmine" in insects.

NEW SOUTH WALES.

Linnean Society, September 29.—Mr. A. G. Hamilton, president, in the chair.—H. J. **Carter**: The Australian Strongyliinæ, and other Tenebrionidæ, with descriptions of new genera and species. Representatives of the Australian Strongyliinæ are rare in collections, and are sometimes confused with those of the Cistelidæ. Three genera have been recognised hitherto. Two additional genera and six species are described as new, as well as five species referable to other groups of the Tenebrionidæ.—A. M. **Lea**: Descriptions of new species of Australian Coleoptera. Part xi. One genus and thirty species are described as new.—W. N. **Benson**: The geology and petrology of the great Serpentine-Belt of New South Wales. Part v.: The geology of the Tamworth district. This paper continues the mapping of the Serpentine-Belt into the district made classic by the work of Prof. David and Mr. Pittman, and is chiefly occupied with the stratigraphy of the Devonian rocks. About eighty square miles have been mapped in some detail. The lower, middle, and upper divisions of the Devonian rocks are represented, but the base and the upper limit of the series are not visible in the area studied. The interest centres in the middle Devonian beds. Three horizons of fossiliferous limestone have been recognised, and the known fauna has been greatly enlarged. In particular, the forms Pentamerus and Tryplasma, usually of Silurian age, have been found in these rocks. A definite horizon for maximum development of igneous material has been determined in the middle and upper Devonian series, and the origin of the peculiar intrusive tuffs is discussed. The effects of contact-metamorphism, produced by the Moonbi-granite on the basic igneous, resemble those seen at Dartmoor, and in the Harz mountains.

BOOKS RECEIVED.

The Student's System. By V. Russell. Pp. 113. (London: J. M. Dent and Sons, Ltd.) 1s. 6d. net.

Science and War. By Sir W. Osler. Pp. 39. (Oxford: At the Clarendon Press.) 1s. 6d. net.

Radium, X-Rays, and the Living Cell, with Physical Introduction. By H. A. Colwell and Dr. S. Russ. Pp. x+324. (London: G. Bell and Sons, Ltd.) 12s. 6d. net.

Energy Transformations during Horizontal Walking. By F. G. Benedict and H. Murschhauser. Pp. 100. (Washington: Carnegie Institution.)

Conductivities and Viscosities in Pure and in Mixed Solvents. Radiometric Measurements of the Ionization Constants of Indicators. By H. C. Jones and others. Pp. vii+175. (Washington: Carnegie Institution.)

A Comparison of Methods for determining the Respiratory Exchange of Man. By T. M. Carpenter. Pp. 265. (Washington: Carnegie Institution.)

The Establishment of Varieties in Coleus by the Selection of Souratic Variations. By A. B. Stout. Pp. 80+plates 4. (Washington: Carnegie Institution.)

The Mosquitoes of North and Central America and the West Indies. By L. O. Howard, H. G. Dyar, and F. Knab. Vol. iii.: Systematic Description (in two parts). Part i. Pp. vi+523. (Washington: Carnegie Institution.)

Contributions to Embryology. Vol. iii. Nos. 7, 8, 9. Pp. 90+plates. (Washington: Carnegie Institution.)

A Laboratory Manual for Work in General Science. By O. W. Caldwell, W. L. Eikenberry, and C. J. Pieper. Pp. xi+134. (Boston and London: Ginn and Co.) 2s. 6d.

Laboratory Manual of Horticulture, with Illustrations of Methods, Equipment, and Apparatus. By Prof. G. W. Hood. Pp. vi+234. (Boston and London: Ginn and Co.) 4s. 6d.

Laboratory Manual, Arranged to Accompany "A Course in General Chemistry." By Prof. W. McPherson and Prof. W. E. Henderson. Pp. v+141. (Boston and London: Ginn and Co.) 3s.

A Course in Invertebrate Zoology. By Prof. H. S. Pratt. Revised edition. Pp. xii+228. (Boston and London: Ginn and Co.) 6s.

An Introduction to the Study of Prehistoric Art. By E. A. Parkyn. Pp. xviii+349. (London: Longmans and Co.) 10s. 6d. net.

The Theory of Machines. By R. F. McKay. Pp. viii+440. (London: E. Arnold.) 15s. net.

Handbook of Technical Instruction for Wireless Telegraphists. By J. C. Hawkhead. Second edition, revised and enlarged by H. M. Dowsett. Pp. xvi + 310. (London: The Wireless Press, Ltd.) 3s. 6d. net.

North America during the Eighteenth Century. By T. Crockett and B. C. Wallis. Pp. viii + 116. (Cambridge: At the University Press.) 3s. net.

The Northern Bantu. By Rev. J. Roscoe. Pp. xii + 305. (Cambridge: At the University Press.) 12s. 6d. net.

The Transactions and Proceedings of the Geological Society of South Africa. Index to the first thirteen volumes, 1897–1910. Compiled by A. Reynell. Pp. 196. (Johannesburg: Geological Society of South Africa; London: W. Wesley and Son.)

The Flora of the Nilgiri and Pulney Hill Tops. By Prof. P. F. Fyson. 2 vols. Vol. i. Pp. xxvi + 475. Vol. ii. (illustrations). Pp. 286. (Madras: Superintendent Government Press: London: Thacker and Co.) Price, 2 vols., 15 rupees, or 15s.

National Health Insurance. First Annual Report of the Medical Research Committee, 1914–1915. Pp. 53. (London.)

An Introduction to the Study of Variable Stars. By Dr. C. E. Furness. Pp. xx + 327. (Boston and New York: Houghton, Mifflin and Co.) 1.75 dollars net.

Theory of Measurements. By Prof. J. S. Stephens. Pp. vii + 81. (London: Constable and Co., Ltd.) 6s. net.

Solvents, Oils, Gums, Waxes, and Allied Substances. By F. S. Hyde. Pp. vi + 176. (London: Constable and Co., Ltd.) 8s. 6d. net.

Electric Arc Phenomena. By E. Rasch. Translated by K. Tornberg. Pp. xvi + 194. (London: Constable and Co., Ltd.) 8s. 6d. net.

Canada. Department of Mines. Geological Survey. Memoir 67: The Yukon-Alaska International Boundary between Porcupine and Yukon Rivers. By D. D. Cairnes. Pp. iii + 161. Memoir 70: Family Hunting Territories and Social Life of Various Algarkian Bands of the Ottawa Valley. By F. G. Speck. Pp. 30. Memoir 71: Myths and Folk-lore of the Timiskaming Algonquin and Timagami Ojibwa. By F. G. Speck. Pp. iii + 87. Memoir 78: Wabani Iron Ore of Newfoundland. By A. O. Hayes. Pp. iv + 100 + plates. (Ottawa: Government Printing Bureau.)

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 18.

ROYAL SOCIETY, at 4.30.—On the Theory of the Capillary Tube: Lord Rayleigh.—On the Effect of the Form of the Transverse Section on the Resistance to the Motion of an Elongated Body Parallel to its Length through a Fluid whose Viscosity is not Negligible: Prof. C. H. Lees.—(1) On a Method of Estimating Distances at Sea in Fog or Thick Weather; (2) On a Method of Avoiding Collision at Sea: Prof. J. Joly.—The Flow of Electricity through Dielectrics: S. W. Richardson.—On the Kinetic Theory of Gaseous Viscosity and Thermal Conduction, and the Law of Distribution of Molecular Velocities in the Disturbed State: S. Chapman.

ROYAL GEOGRAPHICAL SOCIETY, at 5.—Distribution of Nationalities of Hungary: B. C. Wallis.

LINNEAN SOCIETY, at 5.—Hollow-shafted Feathers: W. M. Webb.—Photographic Studies of Welsh Vegetation: Dr. E. J. Salisbury.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Inaugural Address by the President, C. P. Sparks.

FRIDAY, NOVEMBER 19.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—The Chemical and Mechanical Relations of Iron, Molybdenum, and Carbon: Prof. J. O. Arnold and Prof. A. A. Read.—The Cause and Effect of "Ghost Lines" in Large Steel Forgings: Prof. J. O. Arnold.

TUESDAY, NOVEMBER 23.

ZOOLOGICAL SOCIETY, at 5.30.—(1) A List of the Snakes of East Africa; (2) A List of the Snakes of North-East Africa; (3) Descriptions of a New Amphisbæna and a New Snake Discovered by Dr. H. G. F. Spurrell in Southern Colombia: G. A. Boulenger.—On some Land Planarians Collected in West Australia and Tasmania: Prof. A. Dendy.—The Morphology of the Cyprinodont Fishes of the Subfamily Phallostethinæ: C. Tate Regan.

ILLUMINATING ENGINEERING SOCIETY, at 8.—Discussion on the First Report of the Departmental Committee on Lighting in Factories and Workshops, opened by Leon Gaster.

WEDNESDAY, NOVEMBER 24.

ROYAL SOCIETY OF ARTS, at 4.30.—Constantinople Ancient and Modern: Sir Edwin Pears.

THURSDAY, NOVEMBER 25.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* The Measurement of the Rate of Heat Loss at Body Temperature by Convection, Radiation and Evaporation: M. Flack, O. W. Griffith and L. Hill.—The Rate of Absorption of Various Phenolic Solutions by Seeds of Hordeum Vulgare and the Factors Governing the Rate of Diffusion of Aqueous Solutions across the Semi-permeable Membranes: Prof. A. J. Brown and F. Tinker.—The Controlling Influence of Carbonic Dioxide. III. The Retarding Effect of Carbon Dioxide on Respiration: F. Kidd.—The Growth of the Body in Man; The Relationship between the Body Weight and the Body Length (Stem Length): E. W. A. Walker.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Some Difficulties of Design of High-speed Generators: Prof. A. B. Field.

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THURSDAY, NOVEMBER 25, 1915.

SCIENCE AND THE PUBLIC.

IN his "Ode on the Coronation of King Edward the Seventh," William Watson wrote of England these notable lines:—

> For now the day is unto them that know,
> And not henceforth she stumbles on the prize;
> And yonder march the nations full of eyes.
> Already is doom a-spinning. . . .

To some of us who were painfully aware of the apathy of British statesmen and of the British public towards the claims of science for truer recognition, these words, when they were uttered thirteen years ago, came as the words of a seer. The fallacy of misplaced optimism, that England would somehow "muddle through," was then rampant; England had always stumbled on the prize of success; chance might be trusted that she would stumble on it again. Ignore the men who know; distrust the expert; let us go on with our muddling; let us play golf and shoot our pheasants, and let other nations scheme, and sweat, and cultivate science! It seemed at one time as though some attempt was being made to remedy this national apathy. The creation by Parliament, half a century back, of a Science and Art Department, suggested at least an amelioration of the old bad state of things; and efforts were made—hopeful efforts, and not unsuccessful in a way—to foster the teaching of science in the older universities and build up newer institutions on a basis of its full recognition. These efforts, though they have by no means failed, have not, however, brought about public recognition to a degree commensurate with the national need, or comparable with the recognition accorded to science in Continental nations, including the central European empires with which we are now in armed conflict.

It is unfortunately only too well known to scientific men that for more than a generation past the trend of public opinion, at least as represented by politicians, statesmen, departmental officials, municipal authorities, and including even the heads of many great industrial and commercial undertakings, has been to ignore the position of science in the fabric of civilisation, and to treat the development of science as though it were a matter of little moment to the national welfare. It has required nothing short of the most terrible war of all time to awaken the nation to its slackness in many things. Indeed, the nation has as yet not begun either to realise how dearly it is paying for its neglect of science, or to reconstruct on a scientific basis its politics, its statesmanship, its commerce, its education, its civil and industrial administration. Distrust of the expert, of the man who has made it his business to know, is still the fashionable, if not the prevalent attitude towards men of science. The public which purchases every morning and evening the halfpenny journals, and swallows the pabulum which they provide, is the same public which elects our Parliamentary representatives and rules most of our national institutions. Occasionally the daily papers deign to insert a paragraph of what they think to be scientific news. If the public prefers its sensational tit-bit of science-gossip, culled from the pamphlet of some pseudo-scientific charlatan and served up hot by an anonymous paragraphist, to more sober and informing articles written by men whose authority is indisputable, the public has itself to thank. Editors and sub-editors do not know enough science to suppress the twaddle; and, consequently, blunders which would be thought amazing if perpetrated in a like fashion in the domains of literature or art or history, are put into gratuitous and harmful circulation.

In political circles the same indifference to science prevails. Apart from the handful of university members, which includes Sir Joseph Larmor and Sir Philip Magnus as the sole representatives of the most neglected branch of human activities, there is not one scientific man in the roll of the House of Commons. In the House of Lords science is indeed represented by two hereditary peers, Lord Rayleigh and Lord Berkeley; but there have been no scientific men called to the peerage since the deaths of Lord Kelvin, Lord Lister, and Lord Avebury. The esteem in which science is held may be measured by the suggestion in Lord Dunraven's scheme for the reform of the House of Lords, that in the future it should consist of 400 members, whereof *two* should represent art, literature, and science! When this amazing proposition was put forward not one voice cried out in protest against this insult to science; it was a much more important question whether the bishops shall continue to be peers. In less august circles the same astonishing contempt for the claims of science is apparent. Shortly before the death of King Edward VII. the Lord Mayor of London gave a luncheon to our present monarch, then Prince of Wales, and to the Elder Brethren of Trinity House. Distinguished members of the Services, as well as Parliamentarians, were of course invited, and there were lawyers, artists, play-actors, and stock-

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brokers; but not one engineer, chemist, or man of science: at least the newspapers reported none as present. His Royal Highness did not notice the omission; it was an utterly trivial incident, of course. Straws show which way the wind blows.

Not one of the headmasters of the great public schools is a man of science, and very few of the heads of houses in the old universities; though the recent selection of a zoologist and a botanist to such posts of dignity at Cambridge may be a timely concession. If the headmasters and heads of houses are by training and tradition out of sympathy with science, is it astonishing that under-masters and schoolboys, as well as undergraduates, grow up ignorant of scientific method, and despise that of which they are ignorant? Worst of all, in those departments of our schools where science is admitted, it is treated as an inferior study. No doubt our public school system turns out many admirable cricketers and a few scholars; but of the living men who have made their mark in science, how few can thank the public schools for that achievement? At every general election the public—to judge from the Press—is keenly anxious to know how many of the members of the House were reared at Harrow, and how many at Eton. But no one cares how many Fellows of the Royal Society, or members of the Institution of Civil Engineers, or Fellows of the Institute of Chemistry are from Harrow or Eton.

We now suddenly discover in the cataclysm of a terrible war, not only that science has been at a discount in the organisation of the army, but that our industrial and commercial life is disorganised and crippled by the same elementary disregard. Nearly half a century ago Disraeli warned us that the commercial prosperity of a nation might be measured by the prosperity of its chemical manufactures. He was laughed at as though his dictum had been a joke. But it ceases to be a matter for joking when the neglect of science leads to the disappearance of whole branches of those trades that are concerned with the technical applications of chemistry or physics or metallurgy. The loss of the dye-stuff industry; the decay of several branches of the glass industry; the ever-increasing pressure in the metal industries, in the varnish industry, in the watch and clock industry, in innumerable branches of the engineering industries, are serious indications. They are symptoms that something has been rotten in the administration of the State. But they have not occurred without serious warning. Sir Norman Lockyer's weighty British Association address, Professor Perry's trenchant "Neglect of Science," Lord Haldane's earnest pleas for the improvement of education in the interests of national efficiency, all pointed the same moral: *if you neglect science, you do so at your peril.* But these warnings fell largely on deaf ears. The assistance given by Government to the promotion of science has been largely a sham supplemented by a few doles. Government has given, it is true, a large sum for the establishment of the National Physical Laboratory. But the German Government gives three times as much, and the United States Government four times as much, for their corresponding national institutions.

In its wisdom, the Government—not the present one—has merged the Science and Art Department in a Board of Education, a Board which never meets, under successive Ministers of Education, who, however able they may have been, have not in any case been men of eminence in science. In the Army there is unconcealed contempt for and hostility to the opinion of any civilian expert; he is lower than any mere gunner. Even the military engineer is set down as a mere sapper. In the Navy things are not quite so bad, though it required years of agitation to secure even a partial recognition for the naval engineer. Had science been despised in the Navy as it is in the Army, where would Britain have been to-day? In political and financial circles the contempt is complete; science neither goes out vote-catching, nor panders to Stock Exchange operations. It is therefore of no importance. Always, and ever, and again, science is despised and ignored.

If the public, the nation, and its appointed rulers display such blindness, is it wonderful that national interests, civil as well as military, industrial as well as agricultural, suffer grievously when forced to compete with nations sedulously trained in the cultivation of science?

> And yonder march the nations full of eyes.
> Already is doom a-spinning.

TWO MORE BANTU BOOKS.

(1) *A Concise Kaffir-English Dictionary.* By J. McLaren. Pp. xv+194. (London: Longmans, Green and Co., 1915.) Price 3*s.* 6*d.*

(2) *A Manual of the Chikaranga Language.* By C. S. Louw. Pp. x+397. (Bulawayo: Philpott and Collins, 1915.) Price 12*s.* 6*d.* net.

(1) IT is curious that so many industrious persons have issued, in the course of the last eighty years, one-sided dictionaries of Kafir (Xosa) dialect of the great Zulu language, and that no one that I know of has published a *full*

English-Kafir dictionary. Such works as those under review are, of course, valuable, but they would be twice as useful if, in addition to Kafir-English, an English-Kafir section was added. English-speaking people in South Africa will not find the work now under review of as much use or importance as philologists, because it will need endless searching to find therein the equivalent of some English word which they wish to translate into Kafir.

Mr. McLaren, in compiling the work under review, acknowledges his great indebtedness to the previously published monumental dictionary by Dr. Kropf, and to the great Zulu Dictionary of Bryant. Unfortunately, like most writers on the Kafir dialects, he adopts the South African orthography, which is devised without any regard to the existence of other languages in the world requiring to be spelt phonetically, and which ignored most of the suggestions made by Lepsius in his standard alphabet. To express the three or the four clicks used in the South African Bantu the letters *c*, *q*, and *x* are borrowed, oblivious of the fact that all are required and have long since been used in other phonetic systems to express the English ch, the Arabic ق, and the Greek χ. The Arabic guttural ق is of such common occurrence all over the world in languages too numerous to catalogue, that the symbol *q* is required for its expression, and is made use of more logically since this Semitic letter, borrowed by the Greeks and the Romans, had in Phœnician almost certainly the sound of the Arabic ق. In my own work on phonetic spelling, and in my study of the Bantu languages, which is gradually being printed by the Oxford University Press, I have been obliged to devise special type to indicate the clicks, because the symbols offered by Lepsius were too confusing to the eye when written or printed.

The term "Kafir" is, of course, exasperating to the logical mind, as it is nothing more than the Arab term "unbeliever," but it seems to have become permanently established in South Africa, and cannot be set aside—though why linguists like Mr. McLaren should wish to spell it with two f's instead of one is what I cannot understand. There is no general term other than Kafir to include the closely allied western dialects of the Zulu species—Xosa, Tembu, Pondo, Pondomisi, Xesibe. The other well-marked dialects on the east and north are Zulu and Swazi. The "Añgoni" of Gazaland (reaching also to Nyasaland) is perhaps a fourth sub-species. To those who cannot afford the big, heavy, and expensive (but most valuable) Kafir-English Dictionary of Dr. Kropf, the work under review will be useful, as it is light, compact, clearly printed, and priced at only 3*s*. 6*d*.

(2) Chikaranga is, as Mr. C. S. Louw informs us in his preface, the language spoken by the natives of Mashunaland in southern Rhodesia. It is a language divided into several well-marked dialects, and the general name of these is more correctly spelt (as it is pronounced) Karaña. The Karaña language is the southernmost member of that far-spread Nyanja group, which extends over the Shire basin half-way up Lake Nyasa, and includes most of the tongues of the lower Zambezi and of the Zambezi valley as far west as the vicinity of the Victoria Falls. The book under review is quite the best manual as yet published on this important speech. It consists of a grammar, exercises, and a copious vocabulary, virtually a dictionary, English-Karaña and Karaña-English. It is published by Philpott and Collins, Bulawayo, and it is a pity that no indication is given of any London agency, for the work is sure to be in request in that ever-widening circle of Bantu students, not only for its philological interest, but because a knowledge of Karaña is of really great importance to those who are proposing to settle and work in southern Rhodesia and adjoining portions of Portuguese south-east Africa.

H. H. JOHNSTON.

FINITE DIFFERENCES FOR ACTUARIES.

Elements of Finite Differences, also Solutions to Questions set for Part I. of the Examinations of the Institute of Actuaries. Second edition. By J. Burn and E. H. Brown. Pp. iii+289. (London: C. and E. Layton, 1915.) Price 10*s*. 6*d*. net.

THE first edition of this work, which is intended for students preparing for the first examination of the Institute of Actuaries, appeared in 1902. The present edition only differs from its predecessor in the addition to part i. of an alternative demonstration of Lubbock's formula for approximate summation, and of three chapters dealing with Stirling's Interpolation Formula, Interpolation for functions of two variables, and Interpolation of inverse functions.

The first two chapters give a clear and straightforward exposition of the elementary processes and formulæ. In the chapter on Interpolation, the usual Finite Difference methods and that of Legrange are given. In the case of a function which is given for *n* non-equidistant values of the variable, it is suggested that a possible method of procedure is to assume

$$U_x = A + Bx + Cx^2 + \ldots + Dx^{n-1}.$$

This leads to very heavy work which could have been avoided by taking

$$U_x = A + B(x-a) + C(x-a)(x-b) + \ldots$$

where a, b, . . . are the values of x for which the function is given. This is actually given in a later chapter, but its use in this connection is not mentioned. The section on Two-Variable Interpolation seems out of place, in view of the introduction of a chapter dealing entirely with this branch of the subject. The short chapter on Central Differences, which is practically a reproduction of the obsolete, cumbersome, and imperfect demonstration given in the Institute of Actuaries' Text-book, part ii., might well have been dropped, as the work is redone by a better method in the chapter on Stirling's Formula. As is shown in the latter chapter, the formulæ follow at once from assumptions of the form

$$U_x = A + Bx + Cx(x-1) + D(x+1)x(x-1) + \ldots$$

The authors, however, make their demonstrations unduly long by obtaining U_0, ΔU_0, $\Delta^2 U_{-1}$, . . . by detailed expression of U_0, U_1, U_{-1}, . . . in terms of A, B, . . . If U_x had been written in the form

$$A + Bx + \frac{Cx^{(2)}}{2!} + \frac{D(x+1)^{(3)}}{3!} + \ldots$$

the difference of U_x for all values of x could have been written down without the tedious arithmetic which is employed. Two pages are devoted to the C.D. expansions of U_x in which the leading terms are $U_{\frac{1}{2}}$ and $U_{-\frac{1}{2}}$ respectively. All this is quite unnecessary, as the formulæ can be deduced from those already obtained by writing

$$U_x = U_{\frac{1}{2}+(x-\frac{1}{2})} \text{ or } U_{-\frac{1}{2}+(x+\frac{1}{2})}.$$

It is to be regretted that the opportunity was not taken to revise the chapter on Summation. The function is frequently written before the operator, and we have such surprising statements as

$$U_{a+x} = U_a(1+\Delta)^x,$$

$$U_a + U_{a+1} + \ldots + U_{a+n-1} = U_a\left\{n + \frac{n(n-1)}{2!}\Delta + \ldots\right\}$$

and the operators are spoken of as the *coefficients* of U_a. The introduction of the alternative so-called demonstration for Lubbock's formula is unfortunate, as the symbolical method employed is quite unsound, and may be mistaken by students for a proof. The chapter on Interpolation of Inverse Functions, consisting mainly of two examples, is unnecessary, and the examples might have been incorporated with those on Legrange's formula.

Three-quarters of the book (parts ii. to iv.) are taken up with solutions of questions set in the first examination of the Institute of Actuaries between the years 1887 and 1902. The questions include Permutations and Combinations, Binomial Theorem, Probabilities, and Elementary Finite Differences. The solutions are instructive, but those on Finite Differences follow too closely the methods of algebra text-books instead of the neater methods of Finite Differences. The incorrect solution to problem 212 given in the first edition is repeated, and the solution to problem 202, giving the expression of $U_0 + U_1x + U_2x^2 + \ldots$ in terms of differences of U_0, should have been incorporated in the chapter on Summation. It would have been more useful to the students for whom the book is intended if solutions of questions from recent examination papers of the Institute of Actuaries had been given, as the syllabus now includes the elements of Differential and Integral Calculus.

PRACTICAL AND APPLIED CHEMISTRY.

(1) *Practical Physical Chemistry.* By Dr. A. Findlay. Third edition. Pp. xvi+327. (London: Longmans, Green and Co., 1914.) Price 4s. 6d. net.

(2) *Practical Physical Chemistry.* By J. B. Firth. Pp. xii+178. (London: Methuen and Co., Ltd., 1915.) Price 2s. 6d.

(3) *Volumetric Analysis.* By A. J. Berry. Pp. 137. (Cambridge: At the University Press, 1915.) Price 6s. 6d. net.

(4) *A First Course in Practical Chemistry for Rural Secondary Schools.* By W. Aldridge. Pp. xii+122. (London: G. Bell and Sons, Ltd., 1915.) Price 1s. 6d.

(5) *Dyestuffs and Coal-Tar Products: their Chemistry, Manufacture, and Application.* By T. Beacall, Dr. F. Challenger, Dr. G. Martin, and Dr. H. J. S. Sand. Pp. vii+156. (London: Crosby Lockwood and Son, 1915.) Price 7s. 6d. net.

(1) and (2) THE third edition of Prof. Findlay's "Practical Physical Chemistry" contains a description of several new experimental methods, especially in connection with the determination of vapour-densities, surface-tension by the drop method, molecular-weights, solubility and hydrolysis of salts by conductivity-measurements, and the measurement of decomposition and of ionic-discharge potentials. The new edition retains all the merits which have long been recognised in its predecessors.

Mr. Firth's book is of a similar type to Prof. Findlay's, and seems to indicate that a standard course of physical chemistry has now been developed, and is being followed with very little modification in a number of different centres. The coincidence in this case extends not merely to identical illustrations of standard apparatus, but even to the inclusion in each volume of a picture

of a tabloid-press. The general character of the course is now too well known to call for detailed description.

In the opinion of the writer, the time is ripe for a revision of the optical experiments described in books of this type. The Continental form of the Pulfrich refractometer suffers from a seriously-defective form of water-jacketing, and might with advantage be replaced (in the text-book as well as in the laboratory) by the newer English instrument, which has been improved greatly in this respect. Similar statements may be made in reference to polarimetric apparatus, in which the English makers now enjoy a marked superiority, which might well find acknowledgment in books such as those now under review. The time is also ripe for recognising the great technical importance of the newer sources of monochromatic light, and the advantages they possess over those formerly in use. The introduction of lithium into the sodium flame and of a globule of mercury into a warmed hydrogen vacuum-tube provide, for use with a refractometer, a series of four lines which is much superior to the traditional series CDFG, which has come down to us from the period when sunlight was still the chief illuminant for optical experiments; the fact that the instrument will need to be calibrated for these four wave-lengths (*e.g.*, with a crystal of quartz) is a real advantage from the point of view of the training of the student. For polarimetric work the enclosed mercury arc, which has now almost displaced the sodium flame, both in technical and in scientific laboratories, is ripe for description in the text-books; and it ought to be followed very soon by a description of Dr. Sand's enclosed cadmium arc, the brilliant invention of an English worker, which promises to revolutionise all those branches of optics which depend on the utilisation of powerful sources of monochromatic light. It is curious that both authors should be content with jacketed polarimeter tubes in which only about three-quarters of the liquid is under the direct control of the circulating water.

(3) Mr. Berry's "Volumetric Analysis" represents a distinct advance upon most of the smaller books on the subject, though its advantages are largely neutralised by the very high price which is charged for a volume of less than 140 pages. The method of treatment is more scholarly than is usual in a small text-book, and the inclusion of a chapter on the "Theory of Indicators," based on Mr. Tizard's well-known report, affords welcome recognition of the scientific aspects of the subject. If issued at half the present price the book could be commended heartily for general use in the many laboratories in which volumetric analysis is now taught.

(4) Mr. Aldridge's book is little more than a skeleton, on which a useful course of elementary chemistry may be built up; but it gives the impression that the author is alive to the various educational features that may be embodied in such a course, and the suggestions which he makes should be of real value to other teachers who have not had so long an experience in work of this kind. Specially welcome is the stress which he lays on the full description written by the pupil of his experiments and observations, a description to be written in pencil at the laboratory bench, but written neatly, arranged logically, and expressed in the best English which the boy can command. Such an exercise is certainly better than the barren attempt to induce a boy to express in a formal essay pious opinions on a subject of which he has no special knowledge, and in which his interest is often non-existent.

(5) Dr. Martin's book on "Dyestuffs and Coal-tar Products," issued as the first of a series of manuals of chemical technology, is reprinted with additions from vol. i. of his well-known book on "Industrial and Manufacturing Chemistry," and does not, therefore, call for a detailed review. The sections reproduced deal with the coal-tar industry, synthetic colouring matters, natural dye-stuffs, dyeing and colour-printing, inks, saccharine and other sweetening chemicals, modern synthetic drugs, and photographic chemicals. The reproduction of these articles is very opportune at the present time, and will be generally welcomed.

T. M. L.

OUR BOOKSHELF.

The Principles of Agriculture through the School and the Home Garden. By C. A. Stebbins. Pp. xxvi+380. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1913.) Price 4*s.* 6*d.* net.

"DAISIES growing a girl" is the title of the frontispiece of this volume and aptly illustrates its aim. Through practical work in garden and classroom juvenile cultivators are led towards a broad outlook as members of the community. Problems of the garden lead, on the one hand, to problems of the farm, market, and finance, and on the other hand, to those of the home, city, and public health. By their own experience the children learn, not only how seeds germinate and where mosquitoes breed, but also how, on a plot of garden ground, each can take his share of responsibility as a citizen. There are score cards for everything from potatoes to personal hygiene. Even the latter the child scores for himself, and his record counts one-half for his own promotion from class to class in school! Such is "school-gardening" as actually carried out in the Western States to-day.

We wish that every school teacher in this country could read this volume. Every page is

exhilarating reading, and the pictures not only illustrate the text, but drive home the lesson, sometimes with irresistible force. To the author science is the basis of healthy life and successful industry. The child is led to ask and answer questions; his appetite is whetted, but never satiated, and he is taught to look for scientific guidance to the State Experimental Station or the proper Government Department, the doors of which (in America) are always open to the inquiries even of children. The school has its proper relation, in some ways almost subordinate, to home and environment in the education of the child. If dollars are often mentioned, it is because they are a measure of the success of each worker in contributing to the well-being of the community. Among some pithy maxims in the preface the following may be commended to teachers: "Do not let such matters as an expensive fence prevent gardening. Get along without the fence. A radish more or less will cut no figure."

Is Venus Inhabited? By C. E. Housden. Pp. 39. (London: Longmans, Green and Co., 1915.) Price 1*s*. 6*d*. net.

THE uninhabitability of most of the worlds of our system—the sun and moon, Mercury, and the giant planets—is practically assured. Our nearest neighbours, Venus and Mars, remain doubtful; speculation as to life on these worlds is natural and quite legitimate, provided it does not claim greater assurance than the evidence warrants.

Mr. Housden is an enthusiastic adherent of Prof. Lowell's views, and has already written "The Riddle of Mars," supporting the artificial nature of its canal system. He now deals with Venus, assuming the 225-day rotation, and the reality of the spoke-like markings drawn by Lowell. The great heat on the day hemisphere causes convection currents, which deposit the moisture as ice and snow just inside the dark hemisphere, whence some of it is supposed to flow in the form of glaciers into the day hemisphere. He supposes that the zone of this hemisphere where the sun is low is inhabited by intelligent beings, who pump the water back along several conduits (Lowell's spoke markings). He claims to reconcile the contradictory conclusions (1) that the 225-day rotation would precipitate all moisture on the dark side, and (2) that the bright side is largely cloud-covered. But he has built a large superstructure on a slender basis of observed fact.

The Romance of the Spanish Main. By Norman J. Davidson. Pp. 313. (London: Seeley, Service and Co., Ltd., 1916.) Price 5*s*.

THIS "Record of the most daring deeds of some of the most famous adventurers, buccaneers, filibusters, and pirates in the western seas," as the sub-title describes the volume, will fascinate boy readers and incidentally teach them much history and a helpful amount of geography, especially if they will trace the various voyages described on a good map. The book is well illustrated and attractively bound.

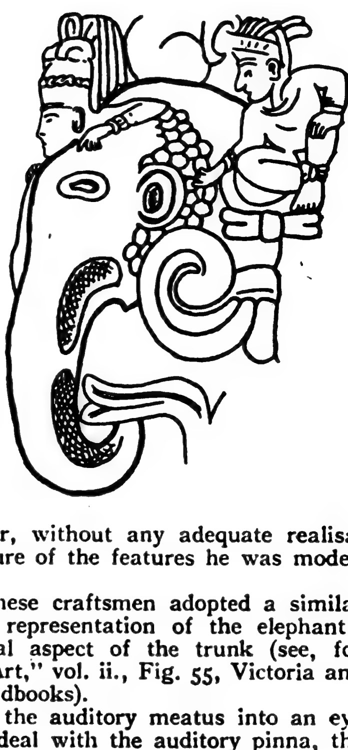
LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Pre-Columbian Representations of the Elephant in America.

MORE than sixty years ago, in his "Incidents of Travel in Central America," Stephens directed attention to an elaborately carved "idol" at Copan, and stated that "the two ornaments at the top look like the trunks of elephants, an animal unknown in that country."

No one who looks at the accompanying tracing, which I have taken from Dr. A. P. Maudslay's magnificent atlas of photographs and drawings of the Central American monuments (Godman and Salvin's "Biologia Centrali-Americana," Archæology, plate xxxiv.), should have any doubt about the justification for Stephens's comment. Moreover, the outline of the head is so accurately drawn as to enable the zoologist to identify the original model for the design as the Indian species of elephant. It is equally clear that the sculptor of the monument was not familiar with the actual animal, for, according to Drs. Maudslay and Seler, he has mistaken the eye for the nostril, and the auditory meatus for the eye, and represented the tusk (note its relation to the lower lip) and the ventral surface of the trunk in a conventionalised manner, without any adequate realisation of the true nature of the features he was modelling.



Certain early Chinese craftsmen adopted a similar convention in their representation of the elephant's tusk and the ventral aspect of the trunk (see, for example, "Chinese Art," vol. ii., Fig. 55, Victoria and Albert Museum Handbooks).

Having converted the auditory meatus into an eye the sculptor had to deal with the auditory pinna, the meaning of which no doubt was a puzzle to him. He resolved these difficulties by converting it into a geometrical pattern, which, however, he was careful to restrict to the area occupied by the relatively small pinna that is distinctive of the Indian species of elephant. (In the representation of elephants on a beautiful Chinese vase of the Ming period, now in the Victoria and Albert Museum, the posterior border of the pinna is lobulated, and suggests a transition to the geometrical pattern of the Copan design.)

The designer also lost his bearings when he came to deal with the turbaned rider of the elephant. No doubt in the original model the rider's leg was obscured by the pinna; but in the Copan sculpture he has lost his trunk also.

All these features go to prove quite conclusively

that the sculpture represents an elephant's head, and that it was not modelled from the real creature. In other words, the craftsman was copying an earlier model (presumably made by some immigrant from Asia) without understanding the "points" of the elephant.

In the introduction to his "Mexican Archæology" (1914) Mr. T. A. Joyce refers to Dr. A. P. Maudslay and Dr. Seler as leading modern investigators who "have done so much to place the study of American antiquities upon a thoroughly scientific footing." It is interesting to inquire what the voice of modern science has to say with reference to these Copan elephants.

In part ii. (text, p. 43) of his great monograph, to which I have already referred, Dr. Maudslay says, in his description of the figure which I have reproduced here:—"The elephant-like appearance of these heads has been the subject of much discussion, but I fail to see any reason why the form may not have been taken from the tapir, an animal still commonly found in the neighbourhood." But if this is so, it is surely a remarkable coincidence that, when the sculptor set about transforming the tapir into so untapir-like a form, he should have arrived at the precise profile of the Indian elephant. Moreover, if the tapir was so familiar to him, why did he mistake its eye for its nostril and its meatus for its eye? Why also did he add the embellishments exactly corresponding in distribution to the elephant's pinna, tusk, and under surface of the trunk, which become meaningless if the creature is a tapir? The position of the turbaned man on the head, as well as the instrument in his hand, also become unintelligible if the head is that of a tapir.

Dr. Eduard Seler holds very different views, which do more credit to his powers of imagination than to his plausibility. For he regards the objects under discussion as heads of tortoises! It is scarcely necessary to follow the remarkable line of argument which led him to this astounding conclusion (*Archiv f. Ethnologie*, 1910, pp. 50–53).

Dr. Seler's view is all the more remarkable in view of the fact that in the same journal two years previously (*Archiv f. Ethnologie*, 1908, p. 716) Dr. W. Stempell (after reviewing the literature concerning these elephant heads from the time of van Humboldt onwards) vigorously protested against the idea that they were intended to be anything else than elephants. He claimed that no one with any zoological knowledge could have any doubt on the matter. But with an amazing disregard for considerations of chronology he suggested that they represent the early Pleistocene *Elephas columbi*!

If these sculptures, definite as their features are, were the only representations of the elephant in pre-Columbian America, one might perhaps be justified in adopting an attitude of reserve as to their significance. But they do not stand alone. Another most remarkable and unmistakable example appears as a head-dress in a bas-relief at Palenque (see Bancroft's "Native Races of the Pacific States of North America," vol iv., p. 305). Another is a highly conventionalised representation of an elephant's trunk, which appears as a projecting ornament on the Casa del Gobenador at Uxmal (Bancroft, *op. cit.*, p. 163).

Equally remarkable instances of the use of the elephant as a design—in these cases the whole creature—will be found in the so-called "Elephant Mound" of Wisconsin, and the "Elephant Pipes" of Iowa (see Henshaw, Second Ann. Report of the Bureau of Ethnology, for 1880–1, pp. 152 and 155 respectively, and McGuire, "Pipes and Smoking Customs of the American Aborigines," 1898, p. 523).

The use of the elephant design in these different ways becomes more intelligible when it is recalled that in India and eastern Asia the elephant was frequently represented on temples and dagobas, and special sanctity became attached to it in religious architecture. Some of the earliest sculptured representations of the elephant in India, going back to the Asokan period (third century B.C.), are found to have the tusk and the ventral surface of the trunk exposed in precisely the same way as the Copan elephants (see, for example, A. K. Coomaraswamy's "Visvakarmā," 1914, plate 91).

Thirty-six years ago Sir Edward Tylor proved that the pre-Columbian Mexicans had acquired the Hindu game called *pachisi* (Journ. Anthr. Inst., 1879, p. 128). Fifteen years later the same distinguished anthropologist directed attention (British Association Report, 1894, p. 774) to the fact that the Mexican scribes had represented in their Aztec picture-writing (Vatican Codex) a series of scenes taken from Japanese Buddhist temple scrolls. If this is admitted—and the facts are much too definite and precise to be denied—the last reason disappears for refusing to admit the identification of the Copan heads as elephants. For if it has been possible for complicated games and a series of strange beliefs (and elaborate pictorial illustrations of them) to make their way to the other side of the Pacific, the much simpler design of an elephant's head could also have been transferred from India or the Far East to America. G. ELLIOT SMITH.

The University of Manchester, November 10.

Commercial Firms and Scientific Inventors.

THE daily Press is now beginning to take up the question of encouraging British inventors with the object of capturing German trade after the war.

May I direct attention to what I regard as a serious deterrent to any scientific man who is capable of producing inventions of practical value.

As many readers of NATURE are aware, after more than ten years' practical experience in the use of piano-players, I patented an expression device, the use of which I found to be absolutely necessary in order to get the satisfaction I required from my music. It has now been put on the market by the Motomusic Company, of 42 Eyre Place, Edinburgh, but both before and after this I found that it was quite impossible to bring it properly before the notice of some of the leading London firms. Had the makers merely raised difficulties of a purely practical kind no objection could have been taken to their attitude, but instead of this their representatives persisted in attempting to talk me down with arguments to the effect that it was theoretically impossible that my invention could produce the results that I claimed for it. It soon became evident that these so-called practical men based their objections on an entire misunderstanding of the principles of elementary dynamics and physics, and it was quite impossible to make them understand things which I could easily have explained to one of my first year students.

It should surely be evident to the most practical business man that a fellow of the Royal Society, who has gained additional distinctions in mathematics and physics, would not waste time and money in patenting an invention unless he were perfectly satisfied as to its unique efficiency on theoretical grounds, particularly if the principles underlying it belonged to the branch of science in which he specialised. I have tried most makes of piano-player, but at the present time there is not one which I would care to play on unless my patented invention were incorporated in it.

It therefore became necessary for me to patent this device independently of commercial considerations, and the Motomusic Company soon realised its advantages. But until the attitude of commercial firms towards scientific inventors has considerably changed I shall continue to avoid undertaking any investigation the results of which may be directly capable of commercial application. If this be impossible, I shall continue to follow my previous practice of rendering such inventions unpatentable by the method of publication; and I advise others to do the same. Of course, there is nothing to prevent Germans from exploiting inventions that have been published without previous protection (*e.g.* the "Thermos" flask). G. H. BRYAN.

The Aurora Borealis of November 5.

WITH reference to the description in NATURE of November 18 (p. 314) of the appearance of the aurora borealis in Yorkshire about 7 p.m. on the evening of November 5, I may mention that I saw it at the same time from the neighbourhood of Broadley Common, in the west of Essex, latitude 51° 45′ N.

It formed a low, colourless luminous arch on the northern horizon, probably about 6° high and 30° in length. There were no streamers, and no movement was visible. J.

November 19.

As a supplement to the observations of Mr. Scriven Bolton on the aurora borealis of November 5, and his beautiful illustrative drawing (NATURE, November 18), may I be allowed to record the following observations. Mr. Scriven Bolton ceased observing at 7.40 p.m.; I began at 8 p.m., although the aurora had been noticed about 7 p.m. The aurora appeared in the form of a bright whitish-green glow, of the form depicted by Mr. Scriven Bolton, extending on the horizon from N. by E., to W. by N., with streamers occasionally rising from it. At 8.25 p.m. the general glow was affected with pulsations, and at 8.40 p.m. five comet-like streamers appeared in the N.W., and a brighter patch of luminosity N. by W. A single streamer appeared in the N. at 8.45 p.m., and at 8.50 p.m. a dark arch formed, separating an upper bright arch from the brightly glowing region beneath. This must not be confounded with the dark segment, so often seen in auroræ surmounted by a bright arch. This particular phenomenon I do not remember to have observed before in auroral displays.

At 8.55 p.m. the luminous arch rose rapidly, reaching to the Pointers of the Great Bear, and became very bright. It then, 8.58 to 9.0 p.m., divided in the middle, and broke up into luminous clouds, which appeared to drift, until a very bright patch was formed due W. The bright clouds had disappeared by 9.2. p.m., but five minutes later the summit of the arch formed again, though it was much fainter than before. It then increased in brilliancy, and disappeared at 9.9 p.m. At 9.12 p.m. a very bright streamer arose in the N.W. At 9.15 p.m. the sky became overcast with dark, filmy stratus clouds. The luminous patch in the W. was also observed earlier in the evening, at about 7.0 p.m. The stars seen through these bright clouds were certainly dimmed in lustre. Looking at the bright glow with a direct-vision prism, I could only see a mere ghost of light in the green.

The aurora was observed during a disturbance of greater intensity on the magnetic needles. A marked easterly movement in declination was synchronous with the formation of the dark arch, and with the rising and marked increase of luminosity of the bright arch. A. L. CORTIE.

Stonyhurst College Observatory, November 20.

A Remarkable Solar Halo.

A SOMEWHAT remarkable halo was visible at Bristol for more than an hour during the morning of Thursday, November 11, between nine and half-past ten. At nine the sky was bright and almost cloudless; a couple of hours or so later it was completely overcast and much rain fell. The halo was white with a slight red coloration on the inside edge, and the whole circle was visible. The most striking feature at 9.30 was the clearness of the sky outside the ring, and its darkness inside. It looked just like a circular cloud of smoke bounded by a bright ring. When measured by my colleague, Mr. Broadbent, the diameter of the halo was found to be 44° 10′.

DAVID ROBERTSON.

Merchant Venturers' Technical College, Bristol, November 17.

Rule for Determining Direction of Precessional Movement.

PROF. A. M. WORTHINGTON has kindly pointed out to me that my interpretation of Prof. Watanabe's rule (NATURE, October 21, 1915) gives the wrong direction of azimuthal turning for the gyroscope. In my statement, *for* upper part of the wheel *read* lower part of the wheel. A. GRAY.

The University, Glasgow.

SCIENTIFIC EXPOSITION AT ITS BEST.[1]

(1) ALL who have enjoyed Sir Ray Lankester's popular essays published in the *Daily Telegraph* under the title "Science from an Easy Chair," will be glad to have a third instalment of them in permanent form; those to whom they are new are to be envied. The mood of the essays expresses the conviction that while science is for foresight and the practical mastery of things, it is also for our delight, "in this world of unending marvels and beauty." Far from echoing the old moan that increase of knowledge is increase of sorrow, the author declares that science "satisfies man's soul." To accept this generous appreciation it may be necessary, however, to include with "science" the attendant feelings and imaginings which are usually kept at a stern arm's length off.

What are the characteristics of these masterly essays, when we get beyond their obvious qualities of learning and lucidity, experience and insight? The first is that Sir Ray Lankester, like Huxley before him, is able to show us the interest and significance of common things. Thus there are illuminating chapters on the sand and pebbles and shells of the sea-shore, on a piece of amber, on sea-anemones and jelly-fish, shrimps and barnacles, on daddy-long-legs, on Christmas trees, and more besides. It is the function of art and poetry to idealise what we see and do every day; but science also has its share (for there are really no hard and fast compartmental *rôles* in life) in showing us the significance of the commonplace, and fine examples of lucid exposition of difficult,

[1] (1) "Diversions of a Naturalist." By Sir Ray Lankester. Pp. xv.+424 (London: Methuen and Co., Ltd.) Price 6s.
(2) "The Birth-Time of the World and Other Scientific Essays." By Prof. J. Joly. Pp. xv.+307. (London: T. Fisher Unwin, 1915.) Price 10s. 6d. net.
(3) "Birds and Man." By W. H. Hudson. Pp. 306. (London: Duckworth and Co., 1915.) Price 6s. net.

though near-at-hand, subjects will be found in the essays on the blood and the lymph.

Another feature is the author's felicitous suggestion of movement. Nothing, not even a fossil, is finished and done with; there is question on the back of question; science is a developing system. So the essays give us problems to stretch our brains over, such as the production of orange-coloured flames under water by rubbing quartz-pebbles together; the moth's flight into the candle; the puzzles of animal courtship; the science of dancing; the missing link, *Eoanthropus dawsoni*, better known as the Piltdown skull; the difference between instinctive behaviour (regarded as due to automatically-working, inherited, "mechanisms of the mind"), intelligent behaviour (regarded as based on learning by individual experience), and the conscious behaviour of man and some higher animals where educability is illumined by self-recognition.

In the essays on palmistry, toads in stones, "dousing," maternal impressions, telegony, and the like, the reader will have the pleasure (or otherwise) of seeing how a "tough-minded" inquirer exposes the weak points of faked evidence. "The whole spirit of science, as contrasted with that of superstition and ignorance, is summed up in the Royal Society's motto, "Nullius in verba" (on no man's assertion!), and King Charles's command, "Don't chatter; make trial!"

Another of the characteristics of Sir Ray Lankester's popular essays is the emphasis laid on making the most of things. Science is for life, not life for science. The question is never far off: Cannot man make more of his kingdom? Thus we find essays on the importance of Nature-reserves, both at home and abroad, where wildness is allowed to flourish and shy creatures feel at home; on the promotion of scientific discovery by money—the plan being to watch for the quite unmistakable discoverer and commandeer him in the service of the State at a generous salary; on the supply of pure milk, and the most effective kind of diet—"not much, but many."

A few more personal chapters complete the charm of the volume, as when the author tells of dredging in Norwegian fjords, of finding a newly-born grey seal on the shore of Pentargon Cove in Cornwall, and of the flowers in the meadowland above Argentière. In regard to the bright colour of Alpine samples of flowers which are paler elsewhere, the author holds that there are genuine high-coloured races (rendered possible by the nutritive vigour of much-sunned plants) which have survived in the short summer of the high Alps since they attract the visits of the pollinating insects more surely than do the paler individuals. It is fitting indeed that our notice of this delightful book should happen to end at a high level!

(2) Prof. Joly's book consists of twelve essays, old and new, all of fascinating interest. They are full of original ideas, they show great expository skill, and they make considerable demands on the reader's intelligence, encouraging him, however, with a fine suggestion of the bracing air of Alpine heights. (The book is illustrated with beautiful photographs of the Alps, to which the author owes some of his inspiration.) The first essay, on "The Birth-time of the World," infers from denudative effects and radioactive products the time that has elapsed (perhaps a hundred million years) since the ocean condensed upon the earth's surface. The second essay argues from the quantity of sodium in the sea to the activity of denudation throughout geological time, and it seems that rather more than a depth of two kilometres of parent rock must have been removed from off the entire land surface of the globe. The essay on "Mountain Genesis" seeks to show that the heat of radioactivity has been a factor in determining the surface features of the earth; and this is followed up by a discussion of Alpine structure. A very ingenious attempt is made to interpret the much-discussed details on the surface of Mars as physical surface features. "Mars presents his

FIG. 1.—The Great Aletsch Glacier. From "The Birth-Time of [redacted] [redacted] World.

history written upon his face in the scars of former encounters—like the shield of Sir Launcelot," and as to the theory of organismal intervention, the author very wisely remarks: "In seeking other minds than ours we seek for what is almost infinitely complex and co-ordinated in a material universe relatively simple and heterogeneous."

Another essay deals with "pleochroic haloes," microscopic darkened spheres in certain of the rock minerals, which turn out to be "a quite extraordinary record of radioactive energy," and afford very striking evidence of the unchanged stability of the common elements since the beginning of geological time. In another discourse the author takes a very hopeful view of the application of radioactivity in medicine, and has some important suggestions to make. A somewhat

technical essay deals with the latent image in photography, while skating is the subject of a very successful popular lecture at a high level. A selectionist interpretation is given of the brightly-coloured Alpine varieties of certain flowers, for pollinating insects are scarce and readily benumbed, and survival rewards variants in the direction of brighter blossoms. To this is appended a theory of the way in which "a unified course of economical expenditure" is impressed upon the organism, and gives to "the developmental progress of the individual its prophetic character." But the theory is stated very elliptically, and does not seem to us to be very clear.

In his concluding essay, which rather takes our breath away, Prof. Joly argues that the present gravitational properties of matter cannot be supposed to have acted for all past duration, and proceeds to speculate concerning the pre-material

FIG. 2.—The Ampezzo Thal. Dolomite Alps. From "The Birth-Time of the World."

state of the universe, when kinetic entities, not yet materialised, exhibited a dreary succession of unprogressive, fruitless motions.

It gave us a pleasant thrill to renew acquaintance after a quarter of a century with a remarkable essay entitled, "The Abundance of Life"—certainly one of the most instructive contributions that have been made to the contrast between animate and inanimate material systems. The contrast is stated in physical terms: "The transfer of energy into any inanimate material system is attended by effects retardative to the transfer and conducive to dissipation. The transfer of energy into any animate material system is attended by effects conducive to the transfer, and retardative of dissipation. The organism is a configuration of matter which absorbs energy acceleratively, without limit, when unconstrained." The attitude of the organism towards energy external to it "results in its evasion of the retardative and dissipatory effects which prevail in lifeless dynamic systems of all kinds." But what is it in the organism that enables it to take the attitude thus so admirably defined?

(3) A re-publication of Mr. Hudson's "Birds and Man" is very welcome, for no such wise and beautiful book should be allowed to get out of print. He tells us of "birds at their best," that is, in their native haunts all-unsuspecting, and of the enrichment which their beauty brings to the open mind; of the reality of sympathy between living creatures, for instance, between wagtail and cow, robin and man; of the pleasingness of all natural sounds heard in their proper surroundings; of the secondary æsthetic element which the voices of some birds have, inasmuch as they approach the expressive tones of the human voice; and of the secret of the charm of flowers, which seems to us to exaggerate, almost *ad absurdum*, the associative factor in æsthetic emotion. His chapters on ravens, owls, and geese are charming and illuminating appreciations; his protests against the "cursed collector" and his patrons, and against stuffed birds as household decorations are still too dismally relevant—though we think that there has been a wholesome change in public opinion to which Mr. Hudson's insight and infectious enthusiasm have effectively contributed. We confess, too, that we have more hope for the conservation of the beautiful along this line than by the severe legislation which the author suggests. At the end the book brings us very picturesquely to Selborne and to an imaginary conversation with Gilbert White, which is high art and sound sense too. The frontispiece of this delightful book is a very fine coloured picture of the furze wren or Dartford warbler.

JOHN DALTON AS A SCIENCE LECTURER.[1]

AS is well known, John Dalton began his academic career at the age of twelve, by a public announcement, affixed to the door of his father's cottage, that he was prepared to impart the elements of a liberal education to the youth of Eaglesfield, of both sexes, on reasonable terms. In actual attainment he was probably not greatly in advance of his scholars—some of whom were lads of sixteen or seventeen, who offered to fight their mentor when disciplinary duty was to be done. In moral power and mental vigour he was more than a match, we may be sure, for even the most pugnacious of his pupils. These qualities doubtless secured for him the ascendency proper to his position as the principal.

During this short apprenticeship to the profession of a pedagogue, Dalton sowed the seeds of his future greatness. A couple of years' experience of self-taught teaching, when wholly dependent upon his own powers of self-reliance, acquisitiveness, and industry, must, at such a period

[1] "John Dalton's Lectures and Lecture Illustrations." Parts i. and ii. by Prof. W. W. Haldane Gee. Part iii., by Dr. Hubert F. Coward and Dr. Arthur Harden. (Manchester: Literary and Philosophical Society, 1915.) Price 1s. 6d.

of his mental development, have greatly tended to form and strengthen his intellectual character. The fact is, Dalton was a born teacher, and, luckily for the world, he realised his true vocation. He then joined his elder brother Jonathan in carrying on Mr. Bewley's school at Kendal, and for twelve years he instructed the youth of both sexes in English, Latin, Greek, and French; writing, arithmetic, merchants' accounts, and the mathematics. It is interesting to trace, from the school syllabus issued by the brothers, how John was gradually drawn to the study of science, first to the oldest of all the sciences, astronomy, and then to the various branches of physics, or natural philosophy, as it was then termed. The late Prof. Huxley used to say to his colleagues, "If you want to get up a subject, offer to lecture upon it," and Dalton would seem, in practice, to have acted upon this principle. The school syllabus was gradually enlarged until, as Sir Henry Roscoe says, it "forcibly reminds us of that of a technical school of the present day."

When twenty-seven years of age, John Dalton accepted the position of tutor in mathematics and natural philosophy at the Manchester Academy, and for upwards of fifty years Manchester continued to be his home until his death at the age of seventy-eight.

For some years prior to his removal to Manchester Dalton had offered to give public lectures, and the Manchester Literary and Philosophical Society possesses copies of the prospectus he issued for courses on natural philosophy to be held at Kendal—"Admittance *6d.* each lecture, or *5s.* the whole." After his removal to Manchester he again arranged for a course at Kendal "as far as the apparatus there would admit"—"about six lectures on chemistry and six on the other branches would be my plan." Tickets for the course to admit a gentleman and lady, or two ladies, *10s. 6d.*; single lectures, *1s. 6d.*

Dalton was now fully embarked on the career of a public lecturer on science, and until he was close upon seventy years of age there were few years in which he was not called upon to give courses. At the instigation of Davy he was early invited to London—Albemarle Street sharing with Athens a passion for the newest thing—to receive from the youthful *protégé* of Rumford, himself some twelve years Dalton's junior, instruction in declamation, and in the art and mystery of holding the attention of a Royal Institution audience.

In the publication before us Dalton's later career as a science lecturer is succinctly set forth. He repeated his London lectures in Manchester. "In a populous town like this, where the arts and manufactures are so intimately connected with various branches of science, it may be presumed that public encouragement will not be wanting to a person qualified to exhibit and illustrate the truths of experimental philosophy upon a liberal and extensive scale." Nor was it. John wrote to Jonathan that "a more respectable audience has seldom been had on a similar occasion." In 1807 he was invited to Edinburgh, and subsequently to Glasgow, where, as he says, "he was honoured with the attention of gentlemen, universally acknowledged to be of the first respectability for their scientific attainments, most of whom were pleased to express their desire to see the publication of the doctrine." The "doctrine" thus indicated took the shape of that epoch-making work, "A New System of Chemical Philosophy," part i. of which appeared in the following year.

Although the greater number of Dalton's public lectures were given in Manchester, at the rooms of the Literary and Philosophical Society, of which he became the honoured president, or at Thomas Turner's Medical School in Pine Street, or at the Royal Manchester Institution, or at the Mechanics' Institution, where he gave his last lecture, in 1835, on the Atomic Theory, he was readily induced, until age and physical infirmity began to tell upon him, to visit the neighbouring towns, and Leeds and Birmingham were in turn favoured with his presence. All that can be ascertained respecting these various courses, and especially of the diagrams and illustrations used by Dalton in connection with them, most of which seem to have been prepared by himself, is set forth in the interesting account before us. The diagrams, 150 in number, are the property of the Manchester Literary and Philosophical Society, and Prof. Haldane Gee, and Drs. Coward and Harden have done a signal service to the history of one of the most remarkable epochs in science in giving a description of the more important of them, and of the circumstances under which they were first employed by their illustrious author.

T. E. THORPE.

PROF. RAPHAEL MELDOLA, F.R.S.

SCIENCE and the world are alike the poorer by the sudden death of Prof. Meldola on Tuesday, November 16. Naturalist, chemist, physicist, and man of affairs, it is no easy matter to estimate, thus near to that sad event, the value of his work and influence. But we may recall the facts that at the time of his death he had been for thirty years professor of chemistry at the Technical College, Finsbury, a part of the City and Guilds of London Institute, that he was also a vice-president of the Royal Society, a member of the Advisory Council appointed by the Privy Council to promote scientific research in relation to trade and industry, and chairman of the Advisory Council of the Board of British Dyes (Ltd.), a commercial organisation fostered by Government to assist in the manufacture of dyestuffs in the United Kingdom.

Raphael Meldola was the only son of the late Samuel Meldola, and was born in Islington July 19, 1849. They came of an ancient Sephardic family, the Sephardis being Spanish and Portuguese Jews, the more aristocratic section of the race. The genealogy of the Meldolas can be traced through sixteen generations without a break, back to Isaiah Meldola (*b.* 1282, *d.* 1340), of Toledo. Under Spanish names the family flourished long in Toledo, and produced many men of

note and learning. The name Meldola seems to have been assumed from the place of that name not far from Ravenna, when some of the family established themselves in Italy. The earlier members of the family for many generations were the Chief Rabbis of their communities.

Raphael Meldola was educated in private schools and the Royal College of Chemistry. At a very early age he was for a time in the private research laboratory carried on by Dr. John Stenhouse, F.R.S., and after two years in a colour works at Brentford, he joined, in 1872, the teaching staff of the Royal College of Science under Prof. Frankland. His training, therefore, had been chemical, but it is interesting to notice how his inclinations often led him in other directions, for the first seven papers under his name in the Royal Society catalogue all relate to subjects of natural history, especially in connection with mimicry and protective colouring in insects. This interest he always maintained, and he was twice president of the Essex Field Club (1880–83 and 1901–2), and later president of the Entomological Society in 1895–97.

While still at South Kensington he assisted Sir Norman Lockyer in spectroscopic work in the Solar Physics Laboratory, and in 1875 was placed in charge of the British Eclipse Expedition to the Nicobar Islands in the Bay of Bengal.

By the outer world, however, Meldola has always been thought of chiefly as a chemist specially familiar with the chemistry of colouring matters. His first paper on a chemical subject was, in fact, a "Preliminary Notice of a New Yellow Colouring Matter," published in 1878. This was followed immediately by studies in the naphthalene series, and three years later he announced a "New Class of Colouring Matters from the Phenols" in the Transactions of the Chemical Society (1881). In the meantime he had joined the firm of Messrs. Brooke, Simpson, and Spiller, in whose works at Hackney Wick he remained eight years, and where he made important practical discoveries, including the dye known in Germany as Meldola's blue. While at Hackney he was associated with the late Mr. R. J. Friswell and with Prof. A. G. Green, now of Leeds University, with whom he retained a close friendship, and from whose competent pen we may expect to receive before long a full account of Meldola's technical as well as scientific colour researches.

In 1885 Meldola was appointed to the chair of chemistry in the Technical College, Finsbury, and there he taught many generations of students, in the list of whom are to be found the names of Profs. Forster, Morgan, and W. J. Pope, all fellows of the Royal Society, besides many others well known in the teaching or industrial worlds.

As to his work at Finsbury, Prof. Silvanus Thompson, Principal of the college, writes as follows:—"Meldola was invaluable to his colleagues as a wise adviser, a steady, constant, and loyal colleague. He used, however, to complain privately of the considerable proportion of his time which was taken up by correspondence with his students, and with writing testimonials for them, but he never stinted the time or pains he took to respond to appeals for this kind of help. The quantity of work he got through during the last twelve months, and more, is to me simply amazing, and this in spite of the severe illness (involving a surgical operation) of last spring. And he wrote long letters from Bournemouth and elsewhere on details of laboratory organisation and questions of staff arrangements, etc., with minute care. We had many long country walks together, and thus, apart from my daily intercourse with him for thirty years, I had the fullest opportunities of knowing what a richly-stored mind he had, and what a noble simplicity and sincerity of nature was his."

To this testimony, which will be most heartily confirmed by his many other friends, it should be added that while Meldola was by nature a most amiable man, in demeanour modest and undemonstrative, he was a very competent chairman, clear in his judgment, firm when necessary, at the same time full of tact.

Meldola served many societies. In addition to those already mentioned he was president of the Chemical Society (1905–7), of the Society of Dyers and Colorists (1907–8), of the Society of Chemical Industry (1908–9), and of the Institute of Chemistry (1912–15). These offices gave opportunities for the expression of his views about such important public questions as the relation of science to industry and the necessity for research.

"We must take," he says in one place, "a broad, an imperial view of original research if we desire, as we all do, to influence the public mind. Every discovery emanating from your laboratories not only helps to extend the boundaries of our science, but it helps also to uphold the general principle that original research is in itself, and by itself, the most powerful weapon that has been or ever can be wielded by mankind in struggling with the great problems which nature offers on all sides for solution."

Nor must be forgotten the numerous occasions on which Meldola pointed out the cause of the departure of the coal-tar colour industry from this country, where it originated, and warned the British public of what would probably ensue if the indifference prevalent among manufacturers continued to exist in this country. These warnings remained practically unheeded till the outbreak of war forced into prominence the unpleasant fact that this country was destitute of dyes, drugs, and all chemicals of the finer sort. When the history of these times comes to be written Meldola will not be forgotten.

Space does not allow us to do more than recall the active interest he took in biological problems, as indicated by his translation of Weismann's "Theory of Descent" (1882–83) and by his own work on mimicry in insects already mentioned, but it is to be hoped that a full estimate of the value of his researches in this direction will be provided by some of his biological friends.

Among the honours conferred on Prof. Meldola were the honorary degrees of D.Sc. Oxon.,

LL.D. St. Andrews, and in 1913 the Davy Medal of the Royal Society. He was also elected a member of the Athenæum Club under Rule ii. He was president of the Maccabæans in 1911. In 1886 he married a daughter of the late Dr. Maurice Davis, J.P., who survives him.

W. A. T.

Raphael Meldola occupied a unique position. In an age of ever-increasing specialisation he kept alive and fresh every one of the diverse interests that had appealed throughout his life to his many-sided intellect: by sure scientific insight he spoke with authority on them all. What scientific man of our time could have brought out in a single year three memoirs dealing with subjects so far removed from one another as the following?—

"Contributions to the Chemical History of the Aromatic Derivatives of Methane" (Trans. Chem. Soc., May, 1882); "Mimicry between Butterflies of Protected Genera" (*Ann. Mag. Nat. Hist.*, December); "Preliminary Report of the Committee appointed to investigate the Ancient Earthwork in Epping Forest known as the Loughton Camp" (Report Brit. Assoc., 1882, p. 274).

Apart from his researches in organic chemistry, and his work on natural history, Meldola conducted and wrote the report on the Eclipse Expedition to the Nicobar Islands (1875); founded the Epping Forest and County of Essex Naturalists' Field Club, laying down in the inaugural address (1880) the policy and lines of work which have made this society one of the best in existence, gave in the coming-of-age address a *résumé* of all that had been accomplished; wrote, with his friend, William White, the first volume of special memoirs of the club—an account of the East Anglian earthquake of April 22, 1884; took a leading part in founding the Corresponding Societies of the British Association (1883); defended the "scientific use of the imagination" in the study of insects in his first presidential address to the Entomological Society of London (1896); considered the part played by physiological correlation in the utility of specific characters in his second address; delivered the Herbert Spencer lecture at Oxford on "Evolution, Darwinian and Spencerian" (1910).

Meldola was naturally brought, by the immense breadth of his interest, into intimate association with the leaders in all branches of science. Hence, with his well-known unselfishness and warm-hearted appreciation of good work of every sort, he was often applied to for help, and took a prominent part in movements for the recognition of important researches, or for preserving the memory of great men. This and the public work —especially in connection with scientific and technical education and industry in its relations with science—he was constantly called on to perform, cut deeply into his limited time and his strength, which was never great.

Natural history was his first love. He began to write papers, especially dealing with British insects, in 1868, six years before his first chemical research was published. The necessities of space forbid anything more than a brief account of his principal work—the development of the theories of insect mimicry and allied subjects. In this he was encouraged by Charles Darwin, who sent him letters received from Fritz Müller in Brazil, and suggested the translation of Weismann's "Studies in the Theory of Descent" (1881–2). Thus it came about that Fritz Müller's work and the theory of Müllerian mimicry became known in this country almost as soon as in Germany, and penetrated the world through more important and far-reaching channels. These and Meldola's own researches, published in several memoirs, together with his translation of Weismann, greatly enriched by his editorial notes, erected, upon the foundation supplied by Bates and Wallace, the peculiarly British study of the bionomic value of colour, marking, and attitude in nature.

Meldola always spoke with the greatest enthusiasm of his association with Darwin and his visits to Downe. He had the distinction of being proposed by Charles Darwin as a candidate for the fellowship of the Royal Society. Among Meldola's warmest friends were Wallace, Bates, and Trimen, his seniors in the important department of evolution that he made his own. Those who came later and attempted to confirm and extend his work can never forget the encouragement they owe to his constant sympathy and help.

The present writer feels the inadequacy of this brief notice, and regrets that in the allotted space it was impossible to prevent it from bearing the appearance of a list.

In the future period of reconstruction Meldola's many-sided activities and devotion to science would have been a precious asset to the nation; but in this sad hour the loss that presses most heavily is that of a dear friend and brother in science.

E. B. P.

DR. H. CHARLTON BASTIAN, F.R.S.

BY the death of Dr. Charlton Bastian on November 17, the last of a distinguished band of men of science, which numbered among its members Pasteur, Darwin, Huxley, and Tyndall, has passed away.

Born at Truro in 1837, Dr. Bastian was educated at University College and Hospital, London, and graduated M.A. in 1861 and M.D. in 1866 in the University of London. His first appointments were those of lecturer on pathology and assistant physician at St. Mary's Hospital; these posts he held until 1867, when he was elected professor of pathological anatomy in University College Hospital. He afterwards became physician to this hospital, and in 1887 professor of the principles and practice of medicine there.

Dr. Bastian devoted minute and prolonged study to the nature and functions of the brain and nervous system. He was a recognised authority on nervous affections, and was for some years physician to the National Hospital for Paralysis and Epilepsy, as well as being a Crown referee in cases of supposed insanity. His best known

works on the nervous system are "The Brain as an Organ of Mind," "Paralyses: Cerebral, Bulbar, and Spinal," and "Aphasia and other Speech Defects." Herbert Spencer was a life-long friend, and, as one of his trustees, Dr. Bastian was joint-editor of that writer's posthumous "Autobiography." He was also a naturalist of catholic tastes, and contributed a monograph on the Anguillulidæ, a family of free nematode worms, to the Linnean Society and compiled a "Flora of Falmouth."

But it is particularly in connection with the "origins" of life that Bastian's name will be chiefly remembered. Contrary to generally accepted views, he denied that life always originates from pre-existing life, and maintained that, just as presumably in past ages life developed from non-living matter, so at the present time lowly living organisms are, under certain conditions, being generated from non-living elements. He was, in fact, an upholder of the doctrine of spontaneous generation, or, as he preferred to term it, of "archebiosis." By the use of solutions containing colloidal silica and iron, enclosed in sealed glass tubes and sterilised by heat, and maintained under particular conditions of light and temperature, he claimed that after a time micro-organisms, such as bacteria and torulæ and even moulds, developed. His results have been detailed in several papers which have appeared in the pages of NATURE during the last few years, and in "The Beginnings of Life" and "Nature and Origin of Living Matter." Few have cared to undertake the laborious investigations necessary to follow this work, which cannot be said to have been confirmed, though the MM. Mary, of Paris, and a correspondent writing only last week in the *English Mechanic*, state that they have observed the development of lowly organisms in culture tubes prepared according to his directions.

Dr. Bastian also supported the doctrine of "heterogenesis," the sudden appearance of one kind of organism as the offspring of another, *e.g.*, ciliates and flagellates descending from amœbæ. This work was published in book form under the title of "Studies in Heterogenesis." Dr. Bastian maintained his views against all opposition with a tenacity and ingenuity which won the respect of his bitterest opponents. A man of great personal charm and originality he literally died in harness, for up to three or four months ago he was continuing his investigations and planning new experiments with a vigour which showed little decline in spite of his four-score years, and to the last his interest in science he had served so well remained undimmed.

R. T. H.

NOTES.

HIS MAJESTY THE KING has been pleased to approve of the following awards this year by the president and council of the Royal Society:—A Royal medal to Prof. Sir Joseph Larmor, F.R.S., for his numerous and important contributions to mathematical and physical science; a Royal medal to Dr. W. H. R. Rivers, F.R.S., for his important contributions to ethnography and ethnology. The following awards have also been made by the president and council:—The Copley medal to Prof. Ivan Petrovitch Pavlov, for his investigations in the physiology of digestion and of the higher centres of the nervous system; the Davy medal to Prof. Paul Sabatier, for his researches on contact action and the application of finely-divided metals as catalytic agents; the Hughes medal to Prof. Paul Langevin, for his important contributions to, and pre-eminent position in, electrical science.

THE Admiralty announces that Staff-Surgeon G. M. Levick has been specially promoted to the rank of Fleet Surgeon for his services with the British Antarctic Expedition in 1910.

THE council of the Royal Meteorological Society has awarded the Symons Memorial gold medal, which is presented biennially for distinguished work done in connection with meteorological science, to Dr. C. A. Angot, director, Central Météorologique de France, Paris. The medal will be presented at the annual general meeting of the society on January 19, 1916.

IN the death of Lieutenant Frank Stevenson Long, 11th Essex Regiment, British science loses a young man of great promise. Educated at Parmiter's School, he proceeded to East London College as a Drapers' Company scholar in 1906, and graduated with first-class honours in chemistry in 1909. He acted as demonstrator in the chemical department for a year, publishing his first paper on the velocity of addition of alkyl bromides to cyclic tertiary bases in the Transactions of the Chemical Society in 1911. In the same year he took honours in physics, and went to Cambridge, first as a member of the Day Training College, and successively as secretary to the censor and librarian at Fitzwilliam Hall. At the outbreak of war he had already taken the mathematical tripos in the first class, and was intending to sit for physics in the following June. With such careful preparation for his future work and with so wide an outlook, Long was regarded as a man for whom a brilliant career could safely be predicted. He obtained his commission in September of last year, and was killed in action on September 26, 1915.

A BRONZE statue of Captain R. F. Scott, R.N., subscribed for by officers of the Navy, has been erected in Waterloo Place. The statue, which shows the explorer in polar dress, is the work of Lady Scott. Mr. A. J. Balfour, First Lord of the Admiralty, in unveiling the statue on November 5, said that it was not a bad thing even in the midst of a great war to remember how great have been the performances of the British Fleet in times of peace. The statue was to commemorate the hero of one of those peaceful victories which resemble the victories of war, in that it involved danger, struggle, and an heroic death. We are apt to forget how much the Navy has done in the unwarlike and yet most dangerous work of exploration, travel, and of wresting from nature secrets most jealously held. Captain Scott was worthy to be ranked with those two great explorers whose

statues stood not far off—Sir John Franklin and Captain James Cook. He had one great advantage, Mr. Balfour pointed out, over every other man whose memory is commemorated by statues. In most cases the artist has to do his best from such pictures as remain, or from the memory of friends and relatives, but Captain Scott had a happier and far rarer destiny, for his statue had been made by Lady Scott.

THE New School of Tropical Medicine and Research Laboratories in Calcutta are, according to the *Pioneer Mail* of September 8, now ready for occupation. They will be associated with the Calcutta Medical College, so that a constant supply of tropical material will be available for study, and this will be one of the main objects to which research will be directed, viz., the elucidation of disease. Another subject to which study will be devoted will be the pharmacology of Indian drugs; if we may include quinine in this category this drug must take premier place in such researches. The number of research workers at present arranged for is eight—a number by far too small, one would think, for the requirements of the many problems that present themselves for investigation. Let us mention only malaria, dysentery, cholera, kala-azar, ankylostomiasis, filariases, beri-beri. Let us consider any one of these diseases in its etiological, pathological, and therapeutic aspects, and the work before these eight researchers is immense. Further, teaching has to be carried on, which it is to be hoped that the research workers will not be called upon to undertake. However, great undertakings often have small beginnings, and we are certain that important results will soon be forthcoming as the result of this new development.

THE *Times* of November 20 published a rather flamboyant little article, headed "A Surgical Schism." This article said: "Not for half a century at least has the medical world been so sharply divided as it is to-day in regard to the question of the treatment of wounds." Now, it is exactly half a century since Lister, at Glasgow, in 1865, first ventured to treat a compound fracture by plugging the wound with a strip of rag soaked in undiluted and impure German creasote. Pyæmia and septicæmia and erysipelas were ravaging the wards of the old Glasgow Infirmary, and he, relying on Pasteur's work on the "germs of putrefaction," and knowing that creasote was a good "disinfectant," plugged a wound with it. That was the beginning of everything, exactly half a century ago. To-day, there are many methods, but they do not all contradict or exclude each other. Nobody wants to rob the soldier of his little tube of iodine, to be applied to a wound right away; nobody wants to rob him of his little packet of antiseptic or aseptic stuff for a "first dressing." But to this handy and clean use of "Listerism," many other methods have been added; the use of citrates to promote the outward flow of lymph, and the use of a vaccine against sepsis, and the use of a vaccine against tetanus. The use of drainage and drainage-tubes is centuries old, and Lister did more than most men to establish the principles of it. We must not imagine a sort of desperate squabble among our military surgeons, some of them throwing antiseptics to the dogs, and others flooding a big wound with strong antiseptics, and then stitching it up without drainage and sitting on it. The suggestion in the *Times* article that an acute controversy is proceeding upon these matters is unfortunate and misleading.

PROF. EDOUARD PRILLIEUX, member of the French Academy of Sciences, died on October 8, at the age of eighty-six, at his private residence at Malécléche, near Mondoubleau, Loir-et-Cher. To students of mycology in this country his name has been familiar since the publication in 1897 of his "Maladies des Plantes agricoles et des arbres fruitiers et forestiers causées par des parasites végétaux." This book is endeared to the student by its clear style and the refreshing presence of some hundreds of original drawings reproduced faithfully by the engraver. Prof. Prillieux entered as a student in 1850 the "Institut agronomique" at Versailles, and on leaving, his first botanical work was the study of the "powdery mildew" of the vine—that *Oidium* which was then devastating the Continental vineyards. In his book we find a beautiful and faithful drawing of the perithecial stage of this fungus, first found in France in 1892. In 1874 he was appointed professor of economic botany at the Central School of Arts and Manufactures, and two years later, when the "Institut agronomique" was reconstituted at Paris, he was appointed there to the chair of botany. In 1883 Prof. Prillieux became "inspecteur général" in the department of botany, and in 1888 was nominated director of the Laboratory of Vegetable Pathology. In 1899 he succeeded to Naudin in the membership of the Academy of Sciences. Prof. Prillieux made numerous researches into the anatomy, morphology, and physiology of plants, but it was as an investigator into the diseases of plants that he became so well known, and this entitled him to his place as one of the founders in France of plant pathology. Articles from him on this subject appeared frequently in the *Annales des Sci. nat. botanique, Comptes rendus,* and *Annal. de l'Inst. Nat. agronomique.*

IN the October number of *Mind* (New Series, No. 96) Mr. C. D. Broad discusses, in an article which is interesting and suggestive to physicists, mathematicians, and psychologists, as well as to philosophers, the question: "Is our Space Euclidean?" He shows the necessity of distinguishing clearly what we mean by space as distinct from matter, and argues that points of space and their relations are timeless, and that space must be considered as homogeneous. Nor must we conceive space as something which we analyse out of a complex presentation as we do when we distinguish in a musical note pitch and loudness, but, on the contrary, it is something we add to the experienced facts, although not in the Kantian sense of an intuitive knowledge. He shows the inherent weakness, for purposes of ultimate truth, of the common psychological distinction between perceptual and conceptual space, since in one sense all spaces are both conceptual and perceptual. By *our* space we mean a space so constructed as to enable us to deal with the data of all senses and of all men. When we ask "Is our Space Euclidean?" we mean, subject to the conditions that space is to be changeless and

homogeneous and not to act on matter, and that matter is to move about in space, can we construct a system of physics which assumes Euclidean geometry for space and enables us to deal adequately and consistently with all the data that men of science agree to be most worthy to be taken into account?

IN the Annals of the South African Museum (vol. xv., part ii.), Rev. T. R. R. Stebbing publishes part 8 of his account of South African Crustacea, enumerating twenty-two species of macrurous Decapoda, half of which are described as new. In the family Hippolytidæ a new genus is founded, the name of which is the last term in a curious series of word-buildings. Risso established Lysmata, Stimpson founded Hippolysmata, and now Mr. Stebbing gives us Exhippolysmata for a species taken off the mouth of the Tugela River.

Amoeba proteus has been described and discussed in biological laboratories more fully perhaps than any protozoan. Yet Miss L. A. Carter finds several new and interesting points in its cyst, which are described and figured in the Proceedings of the Royal Physical Society of Edinburgh (vol. xix., No. 8). The cyst consists of two membranous walls outside which is an envelope formed of cemented fragments. In the reproduction of encysted individuals from seventy-five to one hundred young Amœbæ were formed by the familiar division-process.

AUSTRALIAN cattle may be affected by nodules below the skin caused by the presence of "nests" of small nematode worms (*Onchocerca gibsoni*). Dr. Georgina Sweet has lately investigated the occurrence elsewhere of such parasites (published by the Ministry of Trade and Customs, Melbourne). She finds that the identical species is present in cattle in the Malay countries, while other species of Onchocerca afflict *Bos indicus* and *B. bubalis* in India. The original host is believed to be the Indo-Malayan Gaur (*B. gaurus*), whence the parasites have been passed to cattle in the Malayan and Australian regions. Unfortunately the mode of transmission is still unknown.

SOME valuable notes on the reptiles of the Okefinokee Swamp of Florida appear in the Proceedings of the Academy of Natural Sciences of Philadelphia (vol. lxvii., part i.) by Messrs. A. H. Wright and W. G. Funkhouser. Their notes on the alligator (*Alligator mississippiensis*) are profoundly interesting. These animals are hunted for the sake of portions of their hides, and are decoyed to their doom at night by means of the glare from a lamp. As they rise to the surface, attracted by the light, they are shot. Particular attention is directed to the coloration of the young, which at first are transversely banded with bright yellow; these bands, however, slowly fade, and in the adult are wanting entirely. On the other hand, the dorsal tubercles of the neck are absent in the very young specimens. The notes on the habits of the lizards and snakes and the colour variation they present are no less valuable. Many features worthy of note are also recorded of the Chelonia of this swamp.

THE *Museums Journal* for November gives an admirable account of the newly-opened Bolling Hall Museum of Bradford. Until recently a private residence, the oldest portions of which date from the fourteenth century, it passed into the possession of the city of Bradford as a free gift from its owner, Mr. G. A. Paley. Much renovation has been done since the building came into the possession of the Corporation. Oak panelling of the seventeenth century had been painted over, ornamental ceilings were underdrawn with lath and plaster, elaborately-wrought mantelpieces had actually been covered to a dead surface with cement and painted to simulate stonework, while the original rooms had been subdivided till they were little more than cupboards. No more fitting home for a museum of archæology could be found than this, which has the further charm of standing in beautiful grounds. In this same number Mr. W. H. Mullens concludes his most readable history of the old Leverian Museum. His account of the dispersal of the collections contains some valuable facts not otherwise accessible.

Two West African cereals of some importance, known by the native names of Iburu and Fundi, are described and figured by Dr. Stapf in Kew Bulletin No. 8. Iburu, *Digitaria iburua*, is grown as a field crop in the Hausa States, N. Nigeria. The spikelets are densely packed, and a single head may contain 1000–2000 grains, which only weigh 0·7 mgr. each, and more than 40,000 go to one ounce. Fundi, *Digitaria exilis*, has been known for some time as a cultivated cereal; the heads of grain are smaller than in Iburu, and the seeds lighter, as about 53,000 seeds weigh an ounce. Fundi, however, is in much more general use by the natives. It is cooked by being thrown into boiling water or used like porridge. It seems probable that it might be appreciated as a light farinaceous food if exported to this country.

FOREST Bulletins, Nos. 27, 28, 29, contain notes on blackwood (*Dalbergia latifolia*), dhauri (*Lagerstroemia parviflore*), and sundri (*Heritiera minor*) respectively. In each bulletin a section of the timber is mounted to show the character of the wood. The text comprises details as to the general distribution of the trees and particulars of their locality and habit in India. Then follow a description of the properties and uses of the timber, an account of the natural reproduction and rate of growth of the trees, notes on the distribution in the different provinces in India, methods of extraction, etc. Sundri is a valuable timber somewhat displaced by teak. Since the sundri and teak forests are not in the same areas, the former timber has escaped the notice of traders, but if extracted it would appear, from a trial sale in Calcutta, to offer prospects of a lucrative business.

THE forests of Victoria, Australia, form the subject of an interesting paper by Mr. A. W. Hardy, read before the Field Naturalists' Club, Victoria, the first part of which is published in their journal, *The Victorian Naturalist*, vol. xxxii., No. 5, 1915. In the opening historical survey it is pointed out that there was little exploitation of the forests until about the

year 1857, when the gold rush to Victoria commenced. Then a demand sprang up for timber for dwellings, culverts, fences, etc., resulting in a deplorable destruction of valuable trees. The huts built were only "wattle and daub" at first, and for these the pliable and tough branches of acacia were used. From this use the popular name wattle has been applied to the Australian acacia, and is in common use to this day. Now, with the establishment in 1907 of a proper State Department of Forests, the care of the timber is assured, and 4,000,000 acres, or 7 per cent. of the total area of the State, is a reserved forest area. An account is given of the different types of Victoria forest, which are characterised chiefly by different species of eucalyptus. Pure forests of one species of these trees are not common, though woods may often consist entirely of several different species of eucalyptus. In the highland glens of Otway and Gippsland groves of the myrtle beech (*Notofagus cunninghamii*) are to be found.

THE *Journal* of the College of Agriculture, Tokyo, for March 20, 1915, contains a short article by Dr. S. Honda on the maximal growth of Japanese timber trees. Dr. Honda's article is illustrated by some excellent photographs of famous Japanese trees. The sacred tree of Arisan in Formosa (*Chamaecyparis formosensis*) attains the height of 40 metres, while the seven-forked Cryptomeria of Takaoka reaches 36 metres.

An extensive paper by Dr. S. Kusano, entitled, "Experimental Studies on the Embryonal Development in an Angiosperm," appears in the *Journal* of the College of Agriculture, Tokyo, for March 20, 1915. The paper is an elaborate study of the reproductive processes in a saprophytic orchid (*Gastrodia elata*), combining the methods of cytological study and experimental or field work, which, as the author says, "are in most cases not well co-operated." As in some other orchids, the embryo-sac has only four nuclei, instead of the usual eight. Triple fusion takes place, but no endosperm is formed. The nuclei in the embryo-sac, which ought to be haploid, are frequently found to show the diploid number of chromosomes (sixteen to eighteen). This points to the possibility of parthenogenesis (apogamy), which, however, could not be induced experimentally. The unpollinated flowers may develop dehiscent capsules and externally normal seeds, but no embryo. Development is further stimulated by certain foreign pollen (especially that of the orchid Bletia), but fertilisation is not effected. The nucleus of an unfertilised egg was sometimes observed to divide; here the nucleus was haploid, so the case was one of incipient true parthenogenesis, as distinguished from apogamy, but it goes no further. Delay in pollination favours poly-embryony, the second embryo being derived from the synergid, which would otherwise provide the "upper polar nucleus." Self-fertilisation, though a chance occurrence in Nature, is quite effective.

IN the *Geographical Journal* for November (vol. xlvi., No. 5) Dr. C. Davison gives an account of the earthquakes in Great Britain from 1889 to 1914. During those twenty-six years the number of earthquakes was no fewer than 357, although not one was accompanied by crust displacements at the surface. Some years were rich in earthquakes, like 1912 with 74, or 1890 with 26, while others, like 1914, 1897, and 1899, had only one. Dr. Davison discusses at length some typical cases, and then the origin of British earthquakes in general.

THE Sahara in 1915 is the subject of a useful paper by Mr. F. R. Cana in the *Geographical Journal* for November (vol. xlvi., No. 5). The summary contains a good deal of information regarding recent French exploration, which is widely scattered and not easy to lay hands on, and it concludes with a discussion of the possibilities of the land. Mr. Cana estimates that over an area of 350,000 square miles, that is, about one-tenth of the Sahara, increased cultivation is possible, and would be profitable. A good deal of well sinking has been done by the French in the Algerian Sahara, with most satisfactory results. Railway extension to some of the larger oases would increase the export of dates.

THE theory that the upper layers of the atmosphere are ionised and therefore conduct electricity, first enunciated by the late Prof. FitzGerald in 1893, has been extensively utilised in recent years to explain the law of decrease of the intensity of radio-telegraphic signals with distance. In an article in the *Revue générale des Sciences* for October 30 Prof. H. Nagaoka, of the University of Tokio, attributes this ionisation to two causes. The first is the utra-violet light of the sun, which he believes is capable of ionising the atmosphere down to about 40 kilometres from the earth's surface. The second is the stream of electrons emitted by the sun, which, owing to the magnetic fields of the sun and the earth, describe paths far from straight and account for the ionisation of the upper atmosphere at night. The greater height of the reflecting layer at night and the consequent reduction in the number of reflections of the waves at the ionised layer and at the earth's surface account for the better transmission of signals at night. The under concave surface of the ionised layer above a station at which the sun is rising focuses the waves from the west near the surface of the earth, and so gives the good signals at dawn. A similar focusing of the waves from the east occurs at sunset. The effect of solar eclipses is explained in the same way, and Prof. Nagaoka points out that as the period of an electrical oscillation on the sun is 6·5 seconds, there should be a corresponding period in the stray signals at terrestrial stations. He hopes radio-telegraphic observers will succeed in detecting this period.

THE October issue of *Knowledge* contains an article on "Eutectics," by J. L. Haughton and D. Hanson. In addition to a clear account of the properties and structures of these important alloys, the authors give a series of eight photographs of typical eutectics. These photographs, admirably reproduced on a large scale from various originals, are amongst the finest illustrations of the kind that have been offered to the general public. The publication of such illustrations should go far to convince those who are interested in the industrial employment of alloys that it is worth while to study their structure and to make use of the

additional knowledge that has been rendered available during the past twenty years or so.

THE spontaneous racemisation of optically active compounds is discussed by S. Komatsu in the third of his "Studies in the Stereochemistry of Quinquevalent Nitrogen" (Mem. Coll. Sci., Kyoto, vol. i., No. 5, July, 1915). In the case of a typical optically-active iodide it was shown that fusion brought about the decomposition shown in the equation,

$$N(CH_3)(C_3H_5)(C_6H_5)(CH_2.C_6H_5)I \longrightarrow N(CH_3)(C_3H_5)(C_6H_5)+C_6H_5.CH_2.I.$$

On allowing the fused mass to stand for a few days the iodide was reproduced, but when purified by recrystallisation from alcohol it was completely inactive. In this way direct proof was obtained of the theory first put forward by Pope in 1899 to account for the autoracemisation of these compounds.

THE fifth part of the Memoirs of the College of Science, Kyoto (July, 1915), contains a complete investigation of the system: sodium sulphate–sodium chromate–water. It is shown that at 15° C. the decahydrates of sodium chromate and sodium sulphate are mutually miscible in all proportions. At 25°, however, the formation of these mixed crystals is limited to 34 mols. per cent. of the chromate. When more chromate is added, the mixed crystals are decomposed, and the anhydrous sulphate separates. On further addition of sodium chromate, a new salt appears, which is probably a hexahydrated chromate not possessing the power of forming mixed crystals with the sulphate at 25° C. Indications have been obtained of the possible formation of a double salt of the composition

$$2Na_2SO_4,Na_2CrO_4,30H_2O.$$

Attention may also be directed to a series of papers in part 3 of these memoirs on the alloys of (1) Sb and Te, (2) Te and Se, (3) Te and Sb, (4) Tl and Se. These include a complete investigation of each system from the point of view of the phase rule, and are illustrated by microphotographs of various alloys. The compounds detected include Sb_2Te_3, PbTe, Tl_2Se, TlSe, Tl_2Se_3, whilst Te and Se are shown to form two series of mixed crystals descending to a eutectic point at 95 per cent. Se and 130° C.

IN No. 3 of vol. i. of the Bacteriological Series of the Memoirs of the Department of Agriculture in India, Mr. N. V. Joshi claims to have isolated a new nitrite-forming organism from soil, differing morphologically from others hitherto known. Its thermal death point lies between 70° and 80° C., and its optimum temperature of action at between 25° and 35° C. An increased proportion of carbon dioxide in the atmosphere acts as a stimulus to the activity of this organism. 0·2 gm. of glucose in 50 c.c. of Omelianski's solution totally inhibits nitrite formation by this organism, and 0·2 gm. of asparagin greatly retards it. In solutions containing phosphates, ammonium chloride, ammonium sulphate, ammonium carbonate, asparagin and urea serve as sources of nitrogen; in the absence of phosphates, ammonium carbonate is the only substance which can be easily changed to nitrite.

IN a recent review of a small book called "An Introduction to Mining Science" (October 21, p. 198) it was pointed out that in this as in all works which propose to teach just such portions of science as find direct application to any branch of technology the educational benefit to be gained from a study of the science is deliberately sacrificed to expediency. One of the authors of this book has taken exception to this statement. We have no objection to putting his protest on record, but we are unable to open our columns to a discussion of the points raised by the review. Our reviewer holds—and most people will agree with him—that in teaching an art the proper understanding of which requires the knowledge of certain portions of pure science, one of two methods may be adopted: either the student may be taught the science as a systematic entity, and then taught the incidence of such portions of the science as bear upon the industry in question, or else the teaching may be restricted to such portions of the science as are required for the special purpose in view. The former method has a higher educative value than the latter, because the reasoning faculties of a student are educated by the systematic study of the science in its logical development, whilst the latter method, even though it might teach all the scientific facts that bear upon an industry, sacrifices the educative advantages of the former.

MESSRS. Longmans and Co. announce for publication in their series of *Text-books of Physical Chemistry* part ii. of "Electro-Chemistry," by Dr. E. B. R. Prideaux; "A System of Physical Chemistry," by Prof. W. C. McC. Lewis; "Practical Spectrographic Analysis," by Dr. J. H. Pollok; and "Crystallography," by T. V. Barker. In their *Monographs on Physics* will be issued, "The Emission of Electricity from Hot Bodies," by Prof. O. W. Richardson; "Electric Waves," by Prof. G. W. Pierce; and "Atmospheric Ionization," by Prof J. C. McLennan.

MESSRS. WEST, NEWMAN AND CO. have nearly ready for publication, "Vigour and Heredity," by J. Lewis Bonhote. It will be illustrated by coloured and uncoloured plates and diagrams.

OUR ASTRONOMICAL COLUMN.

THE DECEMBER METEORIC SHOWER.—This notable stream is an annually recurring one like the August Perseids, and it will be visible this year at a period when there will be little interference from moonlight. The radiant point apparently moves from near *theta* to alpha Geminorum, and the activity of the display seems prolonged over nearly three weeks. More observations are required as to the place of the radiant on successive nights. As observed by Mr. W. F. Denning at Bristol, the smoothed positions are approximately as under:—

Nov.	25	... 91°+33°	Dec.	6	... 104°+33°
	26	... 92+33		7	... 106+33
	27	... 93+33		8	... 108+33
	28	... 95+33		9	... 109+32
	29	... 96+33		10	... 110+32
	30	... 97+33		11	... 111+32
Dec.	1	... 98+33		12	... 112+32
	2	... 100+33		13	... 114+32
	3	... 101+33		14	... 115+32
	4	... 102+33		15	... 116+32
	5	... 103+33		16	... 117+32

There is a companion shower, often rather strikingly visible at the same time, and its radiant point is about 10 degrees east of the chief system. It apparently shows a similar displacement to the eastwards at the rate of about 1 degree per day.

These showers from Gemini are sometimes extremely active, and on the night of the maximum, about December 11, furnish 20 or 30 meteors per hour for one observer. They have swift flights, not often with conspicuous trains or streaks, and are not recorded so easily and accurately as the meteors from Perseus in August or those from Leo in November.

COMET 1915*d* MELLISH.—Orbital elements for this comet have been calculated by Messrs. S. Einarsson and Alter, of the Berkeley Astronomical Department (Lick Observatory Bulletin, No. 273), from three observations made by Aitken on September 20, 21, and 23:—

$$T = 1915 \text{ Oct. } 13{\cdot}3959 \text{ G.M.T.}$$
$$\left.\begin{aligned}\omega &= 118^\circ\ 50'\ 30''\\ \Omega &= 77^\circ\ 42'\ 52''\\ i &= 53^\circ\ 32'\ 41''\end{aligned}\right\}1915{\cdot}0$$
$$\log q = 9{\cdot}64669$$

Elements deduced by Messrs. Braae and Fischer-Petersen were given in this column for October 14. It is pointed out that the orbit plane is nearly the same as that of comet 1915, also discovered by Mellish. In the current number of the *Observatory* Dr. Crommelin states that the elements show a distant resemblance to those of the comet of 1402.

VISIBILITY OF MERCURY.—The last W. elongation (18° 49′) of this planet occurred on November 7, and although only two-thirds of the possible maximum, the planet was seen by Mr. H. E. Goodson from the Hill Observatory, Salcombe Regis, ten days later on the morning of November 17, just before 6.15 a.m., attracting attention as a *conspicuous* naked-eye object, less than 1° above the eastern sky-line in a moderately bright dawn.

THE LIGHT-CURVE OF RZ CASSIOPEIÆ.—A number of minima of this important circumpolar short-period eclipse variable have been followed by Sig. E. Paci, at the Royal Observatory of Catania (*Mem. Soc. Spett. Ital.*, September). The measures were made by means of a Töpfer wedge photometer attached to a Cooke telescope of 15-cm. aperture. The mean light-curve is based on 2274 measures made during eight minima since last July, and the magnitude ranges from 5·9–7·8 in 2h. 45m.

RECENT SCIENTIFIC WORK IN ITALY.

SINCE the outbreak of war in August, 1914, up to the end of May last, when Italy entered into the struggle, the output of scientific work in Italy seems to have suffered but little from the general upheaval which has in other countries so largely disorganised scientific effort. The *Atti* of the Royal Academy of the Lincei, which may be taken as representative of scientific work in general, embracing as it does all the different branches, shows during this period very little falling off from previous years either in the number or quality of the papers published. This may be seen from a brief review of the contributions of general interest published in vol. xxiii., part ii., and vol. xxiv., part i., which cover this period.

Prof. C. Acqua (vol. xxiii., ii., p. 78) has an interesting paper on the artificial absorption of liquids by the aerial parts of plants, in which a description is given of the striking effects produced by allowing living plants to absorb nutritive solutions through the leaves or cut branches. Plants which ordinarily die down in the autumn were in this way kept in leaf throughout the winter by the absorption of saccharose, whilst in other cases plants placed in unsatisfactory conditions of growth, which ordinarily would cause rapid fading, were revived by administering sugar solutions through the leaves or stalks.

Dr. V. Paolini and R. Lomonaco (vol. xxiii., ii., 123) show that the green essential oil obtained from Italian-grown wormwood (*Artemisia absinthium*) contains about 10 per cent. of a mixture of α- and β-thujones, 48 per cent. of thujylic alcohol, either free or in the form of acetic, isovaleric, and palmitic esters, and smaller proportions of phellandrene, cadinene and a blue oil of undetermined composition.

From a study of the effect of very dilute acids on the germination of oats (*Avena sativa*), Prof. R. Pirotta (vol. xxiii., ii., 166) concludes that the anion and kation of the acid have distinct effects, both chemical and biological, on the plant; the hydrogen acts on the root, and the reaction is localised therein, whilst the effect of the anion is localised on the growing points. From a similar study made by Dr. F. Plate on the effect of the chlorides of the alkali metals on germination, it is seen that the chlorides produce very different effects from the corresponding nitrates, the difference being due to the presence of a different anion.

In two papers on the formation of hydrocyanic acid in plants, Prof. C. Ravenna (vol. xxiii., ii., pp. 222 and 302) points out that in the estimation of small quantities of hydrogen cyanide in such cases, it is preferable to use potassium chromate as an indicator in titrating with silver nitrate solution rather than to employ Liebig's or Denigès's method. It is shown by a number of experiments on *Phaseolus lunatus* that this plant on germination at first produces hydrogen cyanide in increasing quantities, but that after a time the amount falls off. This plant, therefore, is no exception to the rule formerly established by the author with regard to the course of formation of hydrogen cyanide by cyanogenetic plants.

Dr. A. Clementi (vol. xxiii., ii., 517 and 612) describes a new method of determining the action of arginase, based on the quantitative estimation, by means of the formaldehyde process, of the new amino-group formed by hydrolysis of the arginine to urea and ornithine. Arginase is shown to be present, not only in the press juice of the liver of mammals, but also in aqueous extracts of these. In a later paper Dr. Clementi (vol. xxiv., i., 352) shows that Sörensen's titration process in presence of formaldehyde can be applied to mono-substituted amino-acids, such as sarcosine; as slight hydrolysis occurs in such cases, it is, however, necessary, in order that the results correspond with the whole of the acid present, that alkali should be added up to the point when an intense red coloration is produced with phenolphthalein.

Dr. Eva Mameli and Prof. G. Pollacci (vol. xxiv., i., 966) deal with the question of the direct assimilation of atmospheric nitrogen by plants. As the result of numerous analyses conducted under a system of rigorous control, it is concluded that the faculty of assimilating nitrogen directly from the air is far more widely distributed among plants than has hitherto been admitted. Nearly all chlorophyll-containing plants, from algæ to phanerogams, can, under special conditions, make use with greater or less activity of the atmospheric nitrogen. This property is most strongly marked in the Hydropteridæ, such as *Azolla carolinianum* and *Salvinia natans*, and in *Lemna major* and *L. minor*, but phanerogams such as *Cucurbita pepo*, *Acer negundo*, and *Polygonum fagopyrum* also possess it.

A series of papers on the metabolism of amino-acids in the organism is contributed by Dr. U. Lombroso and his collaborators (vol. xxiv., i., 148, 475, 863, and 870). Dr. A. Clementi (vol. xxiv., i., 972) has studied the action of proteoclastic enzymes on polypeptides, and (vol. xxiv., i., 55) the introduction of the guanidine nucleus into the molecule of polypeptides and its significance in physiology.

Amongst papers in pure organic chemistry, the following may be mentioned. E. Sernagiotto has studied in detail *carvone camphor*, a substance formed by the isomeric change of carvone when exposed to light in aqueous alcoholic solution. A. Angeli deals with the properties of certain azoxyphenols and of certain aldehydic compounds, V. Paolini and L. Devizia with the isomeric linalools and the resolution of the inactive form into its optically active components. L. Mascarelli and F. Negrisoli describe the resolution of decahydroquinoline into its optical antipodes.

In inorganic chemistry, Dr. G. Ponti describes investigations of the exhalations from Mount Etna; L. Cambi and G. Sperone have studied the properties of calcium amalgam and give measurements of its electromotive force. The electromotive force of magnesium amalgam forms the subject of a separate paper by L. Cambi.

In physics, A. Lo Surdo has studied the electrical field in the Hittorf-Crookes space, and the electrical decomposition of spectral lines. A. Venturi gives measurements of gravity carried out in Sicily in 1910, and U. Cisotti contributes a mathematical study of new types of permanent periodic and rotational waves. G. C. Trabacchi deals with the Hall effect in alloys of tellurium and bismuth, and P. Cardani describes a method of stabilising the action of Röntgen tubes by absorption of the carbon dioxide.

In the biological sciences, B. Grassi deals with phylloxera, G. Tizzoni with the significance of polymorphism in identifying the streptobacillus of pellagra, and R. Perotti with the morphological variation of *Mycoderma vini*.

W. A. D.

PHYSIOLOGY AT THE BRITISH ASSOCIATION.

AFTER the president's address the reports of several research committees were received. Prof. Waller demonstrated a small apparatus he had devised for the convenient administration of known percentages of chloroform. The regulation of the dose is easily effected, and anæsthesia may be safely induced by the patient himself, the mask falling off the face when the patient is sufficiently under chloroform.

In the report of the committee investigating the electromotive phenomena of plants Prof. Waller described an electrical method of testing the vitality of seeds. The size of the electrical response is directly proportional to the amount of vitality. The method is a great improvement upon existing methods, and should prove of commercial value in the testing of seeds.

Prof. Moore gave a paper on the action of light upon certain inorganic and organic substances. He reviewed the action of chlorophyll in photosynthesis, and showed how similar action could be obtained by the use of inorganic salts in place of chlorophyll. Prof. Moore found that acid salts, and especially iron salts, are most effective, the action being greatest when the colloidal surface is at a maximum. Chlorophyll itself is not the essential element in photosynthesis, but the colloidal salts in the chloroplast. Iron salts are abundant in many of the lower plants, and enable these to make use of the action of light.

Dr. T. W. Edridge-Green, in a communication entitled "Some Fundamental Facts of Vision and Colour Vision," attacked the prevalent assumptions that the rods of the retina are percipient elements, and that there are fundamental colour sensations which by their mixture give rise to other colour sensations. He adduced a number of arguments which he considered destructive of these theories.

Dr. T. W. Graham Brown then illustrated by lantern slides the effects of removal of the post-central gyrus of both sides of the brain upon the movements of a chimpanzee. Shortly after operation the chimpanzee was able to swing from the bars of the cage, using either hand with no sign of inco-ordination. A month after operation the animal showed no symptoms, was able to choose the right key from a bunch, insert it in the keyhole, and unlock and open the door of its room.

Prof. Herring described the effects of thyroidectomy and thyroid-feeding upon the adrenin content of the suprarenals. The adrenin was tested by the action of extracts of the suprarenals upon the blood-pressure of pithed cats after the method employed by Elliott. In a further series the amount of adrenin was measured by Folin's colorimetric process, and expressed in amount per kilo. body-weight. Thyroidectomy reduced the adrenin content considerably, but, when compared with the adrenin content of control animals similarly operated on except for the thyroids being left, it was found there was little difference. In animals which tolerate thyroidectomy, *e.g.* rabbits, there was little difference between the adrenin contents of thyroidectomised and control operated-upon animals a month after operation. Thyroid-feeding, on the other hand, in every case increased the adrenin content above that of the normal animal, and extracts of the suprarenals from thyroid-fed animals gave greater effects upon blood-pressure than similarly prepared extracts from the suprarenals of normal animals.

On Thursday Prof. Bayliss opened the day's proceedings by a paper on "The Mode of Action of Urease." He finds that urease is active in solutions in which it is insoluble, *e.g.* strong alcohol, and therefore acts at its surface by adsorbing urea. Water increases the rate of reaction by mass action or by the intervention of molecular forces in the act of condensation. On this assumption the action of various substances on the rate of reaction may be explained in two ways. The one action changes the degree of colloidal dispersion, and so alters the extent of active surface. Electrolytes show this action either by increasing dispersion and so accelerating the reaction, or by decreasing the surface by aggregation or incipient precipitation and so retarding the reaction. Weak acid and phosphate accelerate the reaction by increasing dispersion; multivalent ions, such as lanthanum, retard the reaction. The other effect may be explained by the substance taking possession of the surface and displacing the urea from it. This is shown by the so-called "surface-active" substances such as amyl alcohol, bile salts, and saponin. Surface energy is depressed and has a negative temperature-coefficient, and Prof. Bayliss finds that the retardation of reaction is greater at low than at higher temperatures. Adsorption of urea by the urease also explains the ratio existing between the concentration of the enzyme and its activity, together with the constancy of the rate of reaction above a certain concentration of the substrate, the latter being due to saturation of the surface. Concentrated solutions of urea greatly retard the action of urease and other enzymes. This is not explained by viscosity or want of water, but is

probably due to some action related to the solvent properties of urea. All attempts at synthesis of urea by urease failed. Prof. Bayliss referred to the complexity of the process of hydrolysis of urea, and believes that the first action of urease on urea is to form ammonium cyanate. The change of ammonium carbamate to carbonate is not accelerated by urease. An interesting discussion of problems raised by the paper followed, in which Prof. Ramsden and Prof. Moore took part.

Dr. J. Tait gave a communication on capillary phenomena in blood cells, and on phagocytosis. He described the movement of the spindle-shaped cells of invertebrate blood in coagulation, and pointed out their analogies with blood platelets. Such cells are phagocytic, but not amœboid; their movement is irreversible and passes into cytolysis. Dr. Tait proposes the name "Thigmocyte" for this class of blood cell. If the thigmocyte is unstable for any substance it is phagocytic for that substance. The movement may be explained physically, and obeys the laws of capillary attraction. Leucocytes, on the other hand, may be stable on a foreign substance, and yet be capable of ingesting small fragments of that substance. Dr. Tait showed that this is not inconsistent with a physical explanation. He further proposed a physical explanation for various blood phenomena, amœboid movement, diapedesis, the relation between agglutinins and opsonins, and the coagulation of blood.

Dr. C. E. Lea showed lantern slides of electrocardiograph records from clinical cases of auricular fibrillation of the heart, and pointed out the value of this method as a mode of diagnosis. The action of drugs on the condition was also illustrated.

Dr. E. P. Poulton read a paper on the alleged acid intoxication of diabetic coma. He analysed a series of cases showing the amount of alveolar CO_2 and the hydrogen-ion in the blood. Dr. Poulton finds no evidence of acid intoxication in diabetic coma; the blood, indeed, shows no increase in H-ion concentration in this condition, and is less acid than in uræmia, or even after moderate exercise. He believes the coma of diabetes to be the direct action of some poison, possibly acetoacetic acid. The lowering of the alveolar CO_2 may be to some extent responsible, and is in itself a trustworthy index to the onset of the condition.

Prof. W. H. Thompson recorded some experiments upon arginine and the formation of creatine. He fed or injected dogs and ducks with arginine, and estimated the output of creatine. In nearly all cases there was an increase of the creatine-creatinine output, injection giving the higher result. Racemic arginine gave no greater effect than dextro-arginine.

Prof. Thompson also contributed a paper on the effects of tetanisation on the creatine and creatinine in the muscle of the cat. A decerebrate animal was used and the creatine estimated by Folin's method. There was an apparent decrease as the result of long-continued activity of the muscle, but Prof. Thompson did not believe there was any real alteration, the apparent decrease being explained by other factors.

On Friday Dr. C. Powell White described a test for copper sufficiently delicate to detect 1/100th of a milligram in 15 c.c. of fluid. The test is identical with Oliver's test for morphine. Dr. Powell White found copper in all the tissues of the body and in various foodstuffs, animal and vegetable. Quantitative measurements were made by the ferrocyanide method. The copper may possibly play an important part in the reactions taking place in the living cell.

Dr. Lamb and Mr. Holker reviewed a number of methods of differentiating fats and lipoids microchemically, and showed lantern slides of tissues thus treated.

Dr. Lamb also illustrated the appearances of the mucous membrane of the small intestine during fat absorption, and showed differences in the columnar cells according to the kind of fat that was administered.

Dr. Sarah M. Baker propounded a new theory of muscular contraction which she termed the "liquid pressure theory." The theory was arrived at in consequence of a similar explanation of the ascent of sap in trees. An aeropermeable membrane, impermeable to liquids but permeable to gases, is assumed to be present in muscle. Carbohydrate is oxidised in the muscle with the production of water and CO_2. The formation of water causes a liquid pressure which manifests itself as a contraction of the muscle. Relaxation is due to rapid evaporation of water through the membrane. The heat thus lost reduces the total energy of the oxidation process by about nine per cent. Dr. Baker cited a number of observations supporting various points in the theory. In the discussion that followed, Prof. Thompson and Prof. Herring criticised the application of this theory to muscle in several details, and Dr. Baker replied.

Dr. Tait and Dr. Harold Pringle then gave a paper on the elasticity of the strophanthinised heart. Tracings of an isolated frog ventricle in Schäfer's plethysmograph were exhibited by the lantern, and the action on it of strophanthin demonstrated. The amount of relaxation of the ventricle was shown to be directly proportional to the preceding contraction, and to be entirely due to the elasticity of the heart.

BOTANY AT THE BRITISH ASSOCIATION.

THE meeting this year was a busy and successful one, though the attendance was smaller than it would have been in happier circumstances, many members being prevented from attending by more urgent calls and duties.

The shadows cast over the meeting by the war were deepened for Section K by the news of the premature death of Prof. D. T. Gwynne-Vaughan, who had been for many years successively secretary and recorder of the section. On Wednesday morning the section adjourned as a mark of respect during the hour of the funeral. A new departure which proved of value scientifically was the setting apart of an afternoon in which readers of papers demonstrated their results, and others also gave demonstrations. It afforded an opportunity for informal discussion which was greatly appreciated. No sectional dinner or excursions were arranged.

The presidential address has already been given in an abridged form in these pages. It embodied a plea for the revival of the causal point of view in morphology, so long neglected in favour of the phyletic aim. Using the alternating generations of the fern, the seed and its embryo, and other examples, the president illustrated the application of distinctively morphological conceptions, such as specific substance, with "allotropic" forms, and the correlation or mutual influence of parts, to the study of form and structure, and emphasised the significance for causal morphology of "homologies of organisation," which have been the bugbear of phyletic morphology.

A feature of the meeting very appropriate in Manchester was a lecture by Mr. Lawrence Balls on the application of science to the cotton industry. Surveying the chief results of his experimental study of the cotton plant in Egypt, he showed how, by suitable sampling, trustworthy statistics could be obtained, from which the growth, flowering, and fruiting of an average plant under average conditions could be cal-

culated. Such data, graphically represented, showed in a striking way correlations between flowering, fruiting, and growth, which might enable an expert to issue at frequent intervals valuable reports and trustworthy forecasts that would have a steadying effect on the market. The lecturer also indicated how careful breeding and selection of pure strains could result in improved spinning quality. Pure strains yield more uniform lint, which will spin well even in cases where the expert grader would reject a sample at first sight as worthless. The need of closer co-ordination between the grower and spinner was emphasised, the chief desideratum being a common language, which might be provided by men of science, so that the spinner could make his requirements intelligible to the grower.

Cryptogams.

Prof. F. O. Bower gave an account of the progress which has been made since the publication of his "Origin of a Land Flora" in the study of the relationships of the Filicales, with special reference to the Dipterids and Pterideæ. While dealing with these in detail he gave a general account of the present state of knowledge with regard to the phylesis of the ferns as a whole. Members of the section appreciated the opportunity of learning the direction in which investigations still in progress at Glasgow were pointing.

Prof. T. G. B. Osborn sent a paper describing the morphology and structure of *Selaginella uliginosa*, which occurs in eastern Australia. It has a well-developed rhizome in which the vascular system is solenostelic, with ramular gaps, a second example of solenostely in the genus. In relation to this Mr. H. B. Speakman demonstrated the structure of the branching rhizome in *Selaginella lyallii*.

Prof. A. H. R. Buller described the discharge of spores from the basidia of Uredineæ and Hymenomycetes. The discharge is violent, a drop of fluid being previously excreted just below the spore, and discharged with it. In many cases the basidia are curved so as to direct the spores towards the open air. Dr. M. Wilson recorded the occurrence of the conidial stage of *Tuburcinia primulicola* on *Primula vulgaris* in Kent. The conidia appear as meal-like masses, partially filling the corolla tube and gluing the stamens together. Conidia may be found in all stages of conjugation by short connecting tubes. Germ tubes are afterwards produced, which probably develop the mycelium that bears the chlamydospores. These arise in groups from coiled masses of hyphæ, and when young contain conjugate nuclei which afterwards fuse. Finally, the whole ovary disintegrates, setting free the spores as a black powder. Mr. W. Robinson demonstrated germ tubes of certain Uredineæ, and abnormal spermogonia.

Fossil Botany.

Dr. Marie C. Stopes gave an account of the remarkable flora of the Lower Greensand deposits of Aptian age, represented by petrifactions, often beautifully preserved, as was amply demonstrated by lantern-slides and actual sections. The flora included Cycadophyta, Conifers, and woody Angiosperms. The wood gives evidence of well-marked seasons, pointing to a cool climate, in marked contrast to the "tropical climate" inferred to have existed at the time of the Wealden flora of southern England.

Prof. F. W. Oliver showed slides illustrating the structure of the seed Gnetopsis, which he has recently further elucidated, and dealt with some general problems of the seed and the flower. Prof. D. Ellis described fungal hyphæ occurring in ferruginous rocks of the Lower Lias, which were incrusted with ferric hydrate, unseptate, with branches, frequently in whorls, and spherical sporangia, each containing about four spores. Another similar fungus, from secondary rocks in north-west Scotland, had a hard black membrane and no sporangia. In fossilised putrefying animal remains were found two Bacilli, a Micrococcus and an Actinomyces-like form, consisting of a thick meshwork of minute threads.

A paper was contributed by Mrs. Edith M. Osborn describing an Australian Zygopteris, probably of Upper Devonian age. This new type is of extraordinary interest. It combines the main features of the *Ankyropteris grayi* type of stele, with the simple Clepsydropsoid type of petiolar structure. Axillary branches were not present. Miss N. Bancroft demonstrated sections showing the structure of the stem and petiole and the mode of branching of *Rachiopteris cylindrica*.

Physiology.

Miss T. L. Prankerd described observations, similar to those of Haberlandt and Nemec, on the coincidence in time and place of geotropic sensitivity and the occurrence of movable starch grains ("statoliths") in certain Liverworts and other plants, illustrated by good microphotographs. Movable starch was located in the top point of the curve of young circinnate fern fronds. In general the nuclei of the "statocytes" were larger than those of neighbouring cells, and in many cases were found among the starch grains at the bottom of the cells.

Dr. Sarah M. Baker directed attention to the enormous fund of energy represented by the total internal liquid pressure of water (corresponding to the pressure of a gas, due to molecular bombardments), which, according to Van der Waals and Stefan, reaches many thousands of atmospheres at low temperatures. Just as osmotic pressure becomes effective in presence of a semi-permeable membrane, so might liquid pressure theoretically become effective, given a membrane permeable to water vapour, but not to liquid water. Dr. Baker suggested that this liquid pressure might account for the ascent of water in tall trees, adducing as evidence of the existence, in the growing region of the root, of a membrane with the requisite properties, (1) that certain dyes do not enter this region, in contrast with the root-cap and root-hairs, and (2) that in a moist atmosphere acid drops of water exude from the root-hairs. The interpretation placed upon these facts was received with some scepticism; it was, moreover, objected that the relatively low values hitherto obtained for root-pressures and the existence of "negative" pressures in the trunks of trees during active transpiration make it abundantly evident that the pumping activity of the root, however it may be explained, is not adequate to the raising of water as fast as the shoot-system actually absorbs and transpires it. On the other hand, attention was directed to the desirability of more extended observations of root-pressures in relation to the heights reached by different species.

Dr. E. M. Delf gave a preliminary account of very careful experiments by a new method on the effect of temperature on the permeability of protoplasm. The rate of contraction (proportional to the rate of exosmosis of water) of strips of plant tissue was followed minutely, and the rate at a specified stage of the contraction was taken as a relative measure of the permeability to water. The results showed a much greater rate of increase at high temperatures than hitherto observed, the curve being logarithmic in form right up to 42°.

Mr. A. M. Smith dealt with the effect of drying on the respiration of plant organs. His experiments showed that with the removal of increasing percentages

of contained water the respiration increases regularly up to 25–30 per cent. loss, when it reached two or three times the respiration of similar undried material. Beyond this point drying had no further effect until 50–60 per cent. of the water had been removed, after which the respiration steadily diminished, not ceasing entirely so long as any water remained in the material.

Prof. W. B. Bottomley gave the results of relative determinations of growth-stimulating "auximones" by means of the bacterial scum formed in their presence on crude nitrifying culture solutions. The relative amounts in fresh and rotted manure and bacterised peat respectively were 1, 5, and 250. The formation of auximones during germination was demonstrated; excised embryos were found to flourish in culture solutions only if auximones were added. Culture experiments with *Lemna minor* showed that the purer fraction precipitated from extracts by silver nitrate stimulates growth more than the cruder phosphotungstic fraction.

Other Papers.

The only foreign guest of the section, Prof. Julius McLeod, of Ghent, demonstrated the possibility, in the case of certain mosses, of describing and determining species biometrically. Using the genus Mnium, as an example, the maximum, mean, and minimum values for the length, breadth, etc., of the leaves on successive portions of the fertile stem up to the longest leaf were tabulated. The results showed that the correlation between these measurements was characteristic of the species, so that by comparing the length, breadth, etc., of, for instance, the longest leaf of a given specimen with data for the longest leaves of the various species, it could be identified.

Dr. J. C. Willis put forward the view, based on a statistical study of the flora of Ceylon and India, that very local indigenous species are those of recent origin, while species widely distributed on the mainland as well, are those long established. He found no evidence of the elimination of species by "natural selection"; most of the widely distributed species are also common, few rare, while of the endemic species the majority are rare.

Dr. E. J. Salisbury described the influence of coppicing on the ground flora of Oak-Hornbeam woods on clay soils. Before coppicing, it comprises chiefly perennial herbs with storage organs which produce their leaves very early in the spring. After coppicing, species from the edges of the wood and paths invade the opened areas, accompanied by weeds of cultivation with good dispersal mechanisms. Some of the old occupants are enabled by the increased light to flower. The soil becomes more acid and drier. The gradual return of the ground flora to its original condition as the undergrowth thickens was described.

In addition to the contributions already mentioned, Mrs. M. G. Thoday demonstrated the structure of seeds of *Gnetum gnemon*, Miss E. M. Blackwell dealt with the occurrence of stomata on hypogeal cotyledons, and other smaller demonstrations were given.

Reports.

Reports on the work of committees of the section were submitted as follows:—By Prof. T. G. B. Osborn, on the cutting of sections of Australian fossil plants; and on Australian Cycadaceæ; by Prof. A. J. Ewart, on investigations of the influence of various atmospheric pressures upon geotropic and heliotropic irritability and curvature; by Mr. R. S. Adamson, on the vegetation of Ditcham Park, Hampshire; by Prof. R. H. Yapp, on the Cinchona Botanic Station in Jamaica; and by Mr. R. P. Gregory, on experimental studies in the physiology of heredity.

AGRICULTURE AT THE BRITISH ASSOCIATION.

ALL interest in agriculture centres at the present time in the economic problems involved in the desired increase of the scope and efficiency of British farming as measured by its output of foodstuffs. It was inevitable, therefore, that the programme of Section M. this year should be largely devoted to the consideration of the existing situation and of the economic factors which govern the introduction of changes in the direction of increased production.

The inaugural address of Mr. Rew, apart from its other merits, served to give the section at the very outset an admirable *résumé* of the existing situation as regards the share contributed by British agriculture to the national food supplies, and more particularly the extent to which it has assisted during the past year in making good the lack of supplies from sources cut off by the war that under normal conditions would have furnished us with some portion of our food. He was able to renew the assurance given by him three years ago at Dundee that, even in normal times, the share of British agriculture in the food supply of the nation is more considerable than is commonly realised. Further, he could demonstrate that this share has been substantially increased during the first year of war, whilst, thanks to the Navy, the total supplies which have reached our shores have been actually rather larger in time of war than in time of peace.

After the address, reports upon the present situation and outlook with reference to supplies of manures and feeding-stuffs were presented by Prof. Hendrick and Mr. E. T. Halnan. Prof. Hendrick directed attention to the difficulties that were likely to arise in connection with the supplies of phosphatic manures, especially "dissolved" manures, owing to the increased cost of imported raw materials and the difficulties of distribution. The loss of supplies of potash manures from Germany could be met only to a very slight extent from other sources, but much might be done to reduce existing waste of potash in the form of loss of liquid manure. The exploitation of seaweed as a source of potash and iodine was also worthy of attention. In a later paper Prof. Hendrick quoted numerous analyses of seaweeds, both Fucus and Laminaria, which showed that the latter contain appreciable quantities of potash, amounting in some cases to fully 12 per cent. of the dry matter.

Mr. Halnan dealt more particularly with the supply of feeding-stuffs, and summarised the results of tests made at different centres with materials new to the British market, such as dried yeast and palm-nut kernel cake.

A further contribution to this day's programme was made by Prof. Somerville, who gave the results of a series of pot-culture experiments which demonstrated clearly the accumulation of fertility in the grass-land of five selected farms as a result of the application of basic slag.

The second day's programme furnished a natural corollary to Mr. Rew's address in the shape of a discussion of various aspects of the present and future agricultural situation as affected by the war. For the purposes of this discussion Mr. T. H. Middleton, Permanent Under-Secretary of the Board of Agriculture and Fisheries, opened the day's programme with an interesting comparison of the efficiency for the production of food of different systems of farming. By ingenious methods of computation he was led to the conclusion that, whereas grazing at its best produces probably not more per acre than sixty-seven days' supply of protein, or 140 days' total supply of energy for a man, and, at its worst, produces no

more than eleven days' supply of each, dairy farming on grass of good quality might be expected to produce 296 days' supply of protein, or 193 days' total energy supply, whilst arable farming on good land producing food crops and meat would give 207 days' supply of protein, or 296 days' total energy supply. Where grass land is attached to the arable land, and all the feeding materials are converted into milk, the energy value of the arable farm is increased to 367 days' food supply, and the protein yield to 383 days' supply. Viewed from this standpoint, the need for a great extension of arable cropping admits of no argument. "Can the nation any longer afford to neglect the development of the resources now lying latent in its unproductive grass land?"

Mr. J. M. Caie, of the Scottish Board of Agriculture, followed with a paper on "The Probable Effect of the War on the Future of Agriculture in Scotland." After reviewing the salient features of Scottish agriculture and the tendencies of comparatively recent changes prior to the outbreak of war, he outlined the principal economic causes that would tend during and after the war to decrease the demand for and lower the prices of agricultural produce. On the other hand, certain other causes would be operative in diminishing supplies, or otherwise raising prices. Balancing these two sets of factors, he inclined to the opinion that prices, both of bread and of meat, will be relatively high, and that, though costs may also be high, increased production will be economically advantageous to the farmer. He did not think that Scottish agriculture would contribute a materially increased output of wheat, since conditions of soil and climate impose severe limitations, but there is room for expansion in the numbers, and improvement in the quality, of stock. In conclusion, he indicated the factors which would be operative in bringing about this increase of numbers.

Prof. T. B. Wood next spoke on the ways in which the agricultural man of science can assist the stock-feeder in utilising existing conditions to the best advantage. He instanced the introduction of new feeding-stuffs and the prevention of waste in feeding as matters in respect of which the scientific adviser can give immediate and trustworthy guidance to the farmer.

The subject of labour and labour-saving machinery on the farm was dealt with by Mr. W. J. Malden. He emphasised the importance of early-training of the agricultural labourer, and urged the desirability of a reform of educational methods in the rural school with this end in view. The development of the use of machinery on the farm would be more rapid when the implement-maker and the motor-maker joined hands. Confused ideas which the effort to adapt attachments suitable for horse-power, but utterly unsuited for mechanical power, have established must be cleared away.

In the discussion which followed the foregoing papers, Prof. W. H. Thompson gave an account of his own estimates of the food production of Irish agriculture which led to conclusions similar to those arrived at by Mr. Middleton.

A paper on the economics of continuous cropping was subsequently given by Mr. Thomas Wibberley, in which he outlined the results obtained by him on various farms in Ireland and elsewhere by following a course of continuous cropping. He claimed that his system obviated certain practical difficulties of cultivation that beset the ordinary systems, and that it was not only more lucrative and more economical of natural resources, but led to a considerable increase in the output of food. The subject is one of great interest, and it is to be regretted that limitations of time did not permit of a fuller discussion in the section.

The third day's programme was designed to be of special local interest, and was devoted largely to problems of milk-production. One contribution which did not come under this head was the paper by Mr. D. Macpherson and Dr. W. G. Smith on the classification, economic value, and possibilities of improvement of the upland grazings of Scotland. Five types have been recognised, and their distribution and characteristics closely studied. Methods of improvement were indicated and discussed.

Of the milk papers, attention was directed specially to two dealing with the problem of the assessment of the cost of feeding in the production of milk.

Mr. J. Mackintosh gave an account of the methods adopted at University College, Reading, in connection with investigations on farms in the surrounding area.

The outstanding point of difficulty is the assessment of the cost of the home-grown foods consumed by the cows. At Reading these foods are charged at the estimated cost of production, whereas in certain cases elsewhere market or consuming price is charged. The effect of this divergent practice upon the results arrived at was well illustrated in the succeeding paper by Prof. Crowther and Mr. Ruston on the results obtained on three Yorkshire farms. They showed that whereas the estimated cost of food consumed per gallon of milk produced was roughly $3\frac{1}{2}d.$ when home-grown foods were charged at cost of production, the estimate was increased to roughly $5d.$ when an arbitrary scale of "consuming prices" was used for these foods. The subsequent discussion centred mainly round this point, and showed considerable division of opinion. Mr. C. S. Orwin urged strongly the desirability of the universal use of the cost of production of the home-grown foods as the basis of assessment, but practical farmers who took part in the discussion inclined mainly to the opposite view that market prices should be charged.

Subsequently Dr. A. Lauder gave an account of experiments in which the effects upon milk-secretion of an addition of calcium phosphate to the food of cows had been studied. In no case could any measurable effect upon either the yield or the composition of the milk be detected.

Prof. Crowther gave an account of experiments which seemed to indicate that the act of milking may be of considerable significance in determining the yield of milk, and especially of milk-fat obtainable at any particular milking. When the "quarters" were milked separately he found that, whereas in the case of the first quarter the percentage of fat in the secretion rose in the main steadily from beginning to end of the milking, this was not the case with the other "quarters." No matter in what order the "quarters" were milked, the percentage of fat was almost invariably lowest in the milk drawn from the quarter milked last. These observations led to the conclusion that the time-factor in milking must be of considerable importance. This was confirmed by an experimental comparison of quick and slow milking. A further comparison of the ordinary method of milking and simultaneous milking of the four "quarters" showed a difference in favour of the latter, which might in practice be appreciable if certain mechanical difficulties were overcome.

The concluding paper of the programme by Mr. A. G. Ruston on "The Plant as an Index of Smoke Pollution" introduced another problem of great local interest. Mr. Ruston dealt with the general type of vegetation in smoke-infested areas, the general appearance of individual smoke-damaged plants, and the specific effects of smoke-damage in plants. His remarks were based upon the work on the subject which has been carried out by him and others during the past

seven years in the agricultural department of the University of Leeds, and were well illustrated by lantern slides. Results were quoted showing a direct correlation between the degree of atmospheric pollution and the activity of plant-growth, the chemical composition of the plant, the activity of the plant enzymes, and the vitality of the seed produced.

The meetings were well attended throughout, and the limited time available for discussion was fully utilised. The proceedings furnished, indeed, abundant evidence that, despite the special circumstances of the year, the steady development of the section is being well maintained.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

LONDON.—The Senate of the University passed the following resolution at its meeting on November 17:—"That the Senate desire to express to Lady Rücker and her family their deep sympathy upon the death of Sir Arthur Rücker, who upon the reconstitution of the University in 1901 was appointed its first principal, and to assure them of their profound appreciation of the great services he rendered to the University during his seven years' tenure of that office."

OXFORD.—In the annual report recently issued by the Committee for Geography, after a sympathetic reference to the death of Prof. Herbertson, facts are given showing the steady progress of the school. This is evidenced not only by the increasing number of regular students, but also by the rapid growth of the collections of maps, books, and other apparatus bearing on the subject of geography. The emergency created by the death of the professor has been met for the time by the appointment as acting-director of Mr. H. O. Beckit, of Balliol College. Special provision for the wants of different ranks of H.M. Forces training at Oxford has been afforded by lectures and other teaching on the geography of the western war area, the influence of the geography of Greece, and military map-reading. These were given by the professor, Mr. Beckit, Prof. J. L. Myres, and Mr. Kendrew. Mr. A. G. Ogilvie, junior demonstrator, is attached to the staff of the Mediterranean Expeditionary Force in a geographical capacity. The report contains also a grateful acknowledgment of the proposal by the family of Prof. Herbertson to present to the school the considerable number of books lent by him to the library.

IT is announced in the issue of *Science* for November 5 that Mr. J. J. Hill has presented 25,000*l.* to Harvard University to be added to the endowment of the professorship in the Harvard graduate school of business administration which bears his name. The James J. Hill professorship of transportation was founded by a gift of 25,000*l.*, announced at the beginning of this session. The General Education Board announces that 20,000*l.* has been given to Carlton College, Northfield, Minn., toward a fund of 80,000*l.*; 10,000*l.* to Hobart College, Geneva, N.Y., toward a fund of 40,000*l.*; 40,000*l.* to Lafayette College, Easton, Pa., toward a fund of 200,000*l.*; and 5000*l.* to Kalamazoo College, Kalamazoo, Mich., toward a fund of 20,000*l.*

IN the course of the academic year 1914–15 a new department was established on a permanent basis in the Mellon Institute of Industrial Research of the University of Pittsburgh, namely, a Department of Research in Pure Chemistry. The headship of this department is to be known as the Willard Gibbs professorship of research in pure chemistry, "ever to proclaim the ideal which the incumbents of the chair and the groups of research workers to be associated with them will be expected to follow." It constitutes a chair in the graduate school of the University of Pittsburgh, as well as in the Mellon Institute. Dr. M. A. Rosanoff, who built up and for years was head of the graduate department of chemistry in Clark University, was formally inaugurated as the first permanent incumbent of this professorship, at a meeting held in the assembly hall of the Mellon Institute on October 26. Addresses were given by Profs. J. McKeen Cattell and M. T. Bogert, both of Columbia University, and by Dr. Rosanoff, followed by a reception and an inspection of the Mellon Institute. Chancellor S. B. McCormick presided at the meeting. He explained the circumstances connected with the establishment of the chair, and thanked the donors whose generosity had made possible the endowment, of which the income, amounting to 1000*l.* per annum, is to constitute the salary of the incumbent of the chair.

THE calendar for 1915–16 of King's College, London, contains detailed particulars of the courses of study provided in the various departments of the institution. The work at King's College in connection with the University of London consists of (1) University of London King's College, with faculties of arts, laws, science, and engineering; (2) King's College Theological Department; and (3) University of London King's College for Women. In the case of the College for Women, the arts and science departments were transferred to King's College, Strand, last January, and the Household and Social Science Department is now situated at Campden Hill, London, W. The faculty of engineering provides a systematic course of study of university character for those intending to devote themselves to engineering. It is so arranged as to give preparation for those wishing to take a degree in engineering at the University of London, and the diploma of the college. Owing to the removal of the Strand School, the engineering department has obtained additional accommodation. For electrical engineering a new lecture theatre and rooms for research, including wireless telegraphy, are provided. The new rooms are now ready for use, and the laboratories are well equipped with boilers, steam engines, gas engine, steam turbine, refrigerating and other experimental plant. The scientific principles which underlie all branches of engineering, together with the methods of applying those principles, are taught in carefully arranged and graduated courses. A noteworthy section of the calendar provides a list of original papers and publications issued by the various departments of the college during the year 1913–14; it runs to some nine full pages, and is excellent evidence of the facilities for research provided by the authorities.

IN March last, Mr. Asquith, in moving the second reading of a Bill to give emergency powers to university authorities, said:—"In no sphere of our national life has the war produced a greater change than in our two ancient Universities." Two recent articles in the *Morning Post* deal with some of the effects of the war on higher education, and serve excellently to demonstrate that not Oxford and Cambridge alone have responded patriotically and abundantly to the call to arms, but the newer universities have taken up the burden with equal manliness and energy. We have no doubt that when Scottish, Welsh, and Irish universities and those in more distant parts of the Empire are dealt with the author will be able to record an equally glorious response. The most conspicuous result of the war from the point of view of Oxford University has been the immense reduction in the number of undergraduates and of resident fellows of

colleges, fully two-thirds of the undergraduates who would otherwise have been in residence being absent on military service. The number of resident undergraduates in the University of Cambridge, which was 3306 in Michaelmas term, 1913, fell to 1658 at Michaelmas, 1914, and a still further decline was observable last term. The number was 1097 at the commencement of the term, but many had disappeared before the conclusion. A similar reduction in numbers is reported, in the articles, in the Universities of Birmingham, Bristol, Durham, Leeds, Liverpool, Manchester, and Sheffield. To mention a few instances: at Durham there are 573 students as against 947 in 1913–14; at Liverpool the undergraduates attending classes this session number 420 and the post-graduates 150, while in 1913–14 the numbers were 548 and 289 respectively; at Manchester there is a decline of more than 500 in the number of men students as compared with 1913.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 18.—Sir William Crookes, president, in the chair.—Lord **Rayleigh**: The theory of the capillary tube. In a recent paper Richards and Coombs comment on deficiencies in the mathematical treatment of the capillary tube, some of which it is here attempted to remedy. In the best experimental arrangement a wide and a narrow tube are connected below, and the difference between the levels of the lower parts of the two meniscuses is measured. In the interpretation of the results for deducing the surface-tension of the liquid, two problems arise (i) how to allow for the weight of the meniscus in the narrow tube, and (ii) to find what diameter is necessary for the wide tube in order that the elevation due to curvature of the liquid surface may be neglected. The first problem was considered by Poisson, but his results in the only really important case, viz., when the liquid wets the walls of the tube, have been disputed. Poisson's formula is here confirmed and extended. If r denotes the radius of the tube, h the measured height of the meniscus above the truly plane level, T the surface-tension, g gravity, and ρ the density of the fluid, $2T/g\rho.r = h + r/3 - 0{\cdot}1288r^2/h + 0{\cdot}1312r^3/h^2$, an approximation which should suffice for experimental purposes. It may be remarked that the first two terms on the right correspond to the assumption of a spherical surface, which is legitimate when r is small enough. A completely adequate solution of the second problem is more difficult. But it is easy to show theoretically that such diameters as are sometimes used for the wide tube (2·5 cm. or 3·0 cm.) are quite insufficient, at any rate in the case of water, a conclusion reached also by Richards and Coombs in direct experiment. It appears further that the widest tube used by these observers (3·8 cm.) would be insufficient to take advantage of the actually achieved delicacy of reading. An approximate calculation of the diameter necessary for this purpose gives 4·7 cm. —Prof. C. H. **Lees**: The effect of the form of the transverse section on the resistance to the motion of an elongated body parallel to its length through a fluid the viscosity of which is not negligible. When a very elongated body moves parallel to its length through a fluid, the resistance due to the viscosity of the fluid varies considerably with the form as well as with the magnitude of the cross-section of the body. Values of the total resistance and of the resistance per unit area of contact with the fluid are given in various cases. In all cases so long as the fluid is in stream-line motion, the law of resistance can be expressed in a simple form, and it is desirable that measurements of the resistance when the motion is turbulent should be made in order to determine the extent to which these laws may be utilised in practical engineering.—Prof. J. **Joly**: A method of estimating distance at sea in fog or thick weather. The method proposed is based upon the different velocities of disturbances in differing media. If aerial and submarine signals are simultaneously emitted at a lighthouse station or light-ship the lag of the aerial compared with the submarine sound is about 4·3 seconds to the nautical mile. An approaching ship picking up the signals and measuring the lag to an error even of one second becomes aware of her distance to less than one-quarter of a mile. Similarly, wireless signals and submarine signals, or wireless and aerial signals, may be used. If the faster-moving signals be sent out in groups, the individual signals being spaced to regular intervals—say, of one second—and the slower moving signal be always emitted simultaneously with the first signal of a group, the navigator has only to count the faster signals until the slower signal reaches him, in order to estimate his distance from the signal station. In this case the signals themselves tell him his distance, and no actual time-measurements are required on board ship. It is shown that this system enables the mariner to determine his position completely in all circumstances which may arise.—Prof. J. **Joly**: A method of avoiding collision at sea. This paper deals with an extension of the method described in the preceding paper for estimating distance at sea to the problem of avoiding collision in fog. It is shown that if vessels possess the means of emitting a loud and crisp sound signal which can be sent out simultaneously with a wireless or a submarine signal, the determination of distance rendered possible thereby, along with wireless information as to course and speed, will enable the navigator on each ship to determine with certainty (1) whether there is risk of collision or whether there is no risk, and (2) the point upon his own course and the moment at which collision is threatened. The solution of the problem is based upon the fact that at each instant the rate of mutual approach is the maximum if the ships are advancing so as to collide. A simple geometrical construction, which by its character is unlikely to involve error, enables the mariner to solve the problem immediately the signals are received.—S. W. **Richardson**: The flow of electricity through dielectrics.—S. **Chapman**: The kinetic theory of gaseous viscosity and thermal conduction, and the law of distribution of molecular velocities in the disturbed state. The first object of the paper is to determine the velocity-distribution function $f(u, v, w)$ in a gas in which there are small variations of temperature and velocity from point to point. Both simple and mixed gases are considered; the mixtures are supposed uniform, the study of diffusing mixtures being deferred to a later paper.

Zoological Society, November 9.—Dr. S. F. Harmer, vice-president, in the chair.—Dr. G. E. **Nicholls**: The anatomy of *Rana tigrina*, the so-called bull-frog of India. Attention was directed to certain features in which this species differs from its European congeners. —Dr. J. C. **Mottram**: Pattern-blending with reference to obliterative shading and concealment of outline. The paper recorded the results of laboratory experiments with artificial patterns. The experiments showed that obliterative, or counter-shading, could be produced by blended black-and-white pattern, and that beyond the blending distance, interruptions at the margin of a pattern, or similarly placed eye-spots, blur the margins. The laboratory experiments were compared with actual patterns of animals.—Dr. J. C. **Mottram**: The distribution of secondary sexual characters amongst birds, with relation to their liability to

the attack of enemies. The paper was based upon a statistical inquiry into the possible existence of a correlation between these factors.—C. Boden **Kloss**: Mammals from the coast and islands of south-east Siam. More than 500 specimens were collected by the author. One species and twenty-two subspecies were described as new.—Prof. W. J. **Dakin**: The fauna of West Australia. (Two papers.) The first paper contained the description of a new land Nemertean, the first to be recorded from West Australia. The second paper described a new prawn-like Crustacean of the genus Palæmonetes, which genus had not hitherto been recorded in Australia.

Mineralogical Society, November 9.—Mr. W. Barlow, president, in the chair.—W. **Barlow**: Crystallographic relations of allied substances traced by means of the law of valency volume. The ordinary parameters of a crystal do not necessarily express the actual ratio between the minimum translations of the crystal structure, and it is justifiable to multiply one or sometimes two of them by a small integer in order to obtain the equivalence parameters. A number of cases were taken which showed that in crystals which either contain the same radicle or closely related radicles the similar parts are arranged in identical strata intercalated between the remaining constituents of the crystal.—A. F. **Hallimond**: Torbernite. From measurements made on several specimens the axial ratio, $a:c=1:2{\cdot}947$ was determined, and the forms 001, 101, 103, 111, 112, besides vicinal faces, were observed. The mineral becomes unstable at vapour-pressures about one-third that of water, and passes into Rinne's meta-torbernite I. At higher temperatures the transition-curve rises sharply, and meets the vapour-pressure curve of water at 75° C., above which torbernite has no stable existence in air.—T. V. **Barker**: The solution of the problem of four tautozonal poles. The indices of two poles, C, D, may be expressed as functions of those of the other two, A(abc), B (def) in the form $(pa+qd,\ pb+qe,\ pc+qf)$, $(ma+nd,\ mb+ne,\ mc+nf)$, where p, q, m, n are small, positive or negative, integers. Since $np \cot \mathrm{AD}=(np-mq)\cot \mathrm{AB}+mq\cot \mathrm{AC}$, a table of natural cotangents enables a numerical example to be solved rapidly. Usually $p=q=1$, and the equation reduces to $n\cot \mathrm{AD}=(n-m)\cot \mathrm{AB}+m\cot \mathrm{AC}$.—L. J. **Spencer**: Crystals of iron phosphide (rhabdite) from a blast-furnace. The small, acicular, tin-white, and strongly magnetic crystals were found sparingly in cavities in a large mass of metal at the bottom of a blast-furnace near Middlesbrough. They are tetragonal (sphenoidal-hemihedral) with the axial ration $a:c=1:0{\cdot}3469$.—Dr. G. T. **Prior**: The meteoric stone of Cronstad, Orange Free State.

Royal Meteorological Society, November 17.—Major H. G. Lyons, president, in the chair.—J. S. **Dines**: The mounting and illumination of barometers and the accuracy obtainable in the readings. The author described the method of mounting and illuminating the barometer in accordance with the plan adopted at the Meteorological Office, South Farnborough. This consisted in hanging the barometer against a window, with a thin wooden screen, 6 in. wide, placed behind it about 1 in. from the tube. In this screen was a narrow slit ¾ in. wide, which came immediately behind the top of the mercury column, and admitted light from the window. The opening in the screen was covered with a piece of ground glass or thin paper, which prevented the passage of direct sunlight and gave a diffused illumination in all circumstances. Another feature of the mounting was the clamping of the bottom of the tube as was generally done in the case of instruments of the Fortin type, in order to prevent swinging of the barometer. The paper also contained an account of several sets of comparative readings of the barometer taken by different observers and between different types of instruments, which showed a remarkably close agreement with one another. The prevalent habit of tapping the instrument before reading was not considered desirable.—N. A. **Comissopulos**: The seasonal variability of rainfall over the British Isles. This paper dealt with a method of presenting rainfall statistics brought forward the year previously by Dr. H. R. Mill and Mr. C. Salter in a paper entitled "Isomeric Rainfall Maps of the British Isles." The author has treated the paper in a slightly different manner from the methods in the paper he has discussed, and has made use of the standard deviation as a measure of variability. The conclusions relating to the distribution of rainfall which arise from this method of discussion are the same as those given by the isomeric maps.

PARIS.

Academy of Sciences, November 15.—M. Ed. Perrier in the chair.—T. H. **Gronwall**: Minimum surfaces forming a family of Lamé.—Léon **Bouthillion**: The application to wireless telegraphy with sparks of the method of charging condensers by dynamos of constant E.M.F.—Albert **Colson**: Heats of equilibrium and the law of saturated solutions.—Paul **Bary**: The velocity of solution of liquids in india-rubber. The experimental results of G. Flusin are shown to be exactly represented by a simple formula.—Emile **Saillard**: The action of copper solutions on saccharose. The estimation of invert-sugar in presence of saccharose.—F. **Kerforne**: The presence of mylonites at the base of the Cambrian at the south of Rennes.—J. **Repelin**: New observations of the tectonic of the north-east portion of Basse Provence.—Henri **Coupin**: The ferment action of marine bacteria. Forty-three species of bacteria of marine origin have been studied from the point of view of their action on sugars and starches. Only four species caused no fermentation, and twenty-eight out of the forty-three fermented glucose.—M. **Marage**: Treatment of loss of speech resulting from shock. Loss of speech is frequently caused by the explosion of shells of large calibre, without any apparent lesions, and this is frequently accompanied by deafness. Details of treatment are given for five cases.—G. A. **Le Roy**: Waterproofing military cloths and fabrics. The materials are treated with solutions of sodium aluminate, dried, and then passed through a bath of weak acetic or formic acid. The material thus treated is waterproof, but not impervious to air.—R. **Kœhler**: Description of a new species of Astrophiura.—A. **Vayssière**: The Eupteropods collected during the scientific expeditions directed by S.A.S. the Prince of Monaco.—Mlle. Janina **Wisznlewska**: Anti-phenol serum. In certain fermentative processes in the intestine a specific substance is produced, always producing by injection into animals definite lesions. Although behaving like a phenol with the reagents used for detecting phenols, it is distinct from oxy-phenylacetic acid or other known phenol derivatives. By injecting this substance into the horse, an anti-body is produced in the serum of the animal, and this neutralises the antigen, both *in vitro* and in guinea-pigs, rabbits, and dogs.

WASHINGTON, D.C.

National Academy of Sciences (Proceedings No. 11, vol. i.).—R. G. **Harrison**: Experiments on the development of the limbs in Amphibia. At the time of appearance of the tail bud, the anterior limb of Amblystoma is already determined in the mesoderm cells of that region of the body-wall which lies close to the pronephros and ventral to the third, fourth, and fifth myotomes. The prospective significance of this

group of cells as a whole thus is defined some time before differentiation becomes visible.—C. G. **Bull**: A mechanism of protection against bacterial infection. Bacteria circulating in the blood are quickly removed when they are agglutinated or clumped, and the clumps deposited within the organs are taken up by phagocytes and digested. They appear not to be destroyed by solution or lysis through the operation of serum constituents of the blood.—C. A. **Kofoid** and Elizabeth B. **Christiansen**: The life-history of Giardia. *Giardia muris* and *Giardia microti* produce a readily recognisable enteritis in mice, and both binary and multiple fission take place in the free non-encysted stage. There is no Octomitus stage. The morphological characters separate six species. The parasite in mice appears to be distinct from that in man.—F. W. **Clarke** and W. C. **Wheeler**: The stony corals have been repeatedly analysed and with generally concordant results. Thirty analyses here made have confirmed the older data. The object of the investigation is to determine what each group of organisms contributes to the formation of marine limestones. The highest proportions of calcium phosphate are commonly associated with high values for magnesia.—C. R. **Stockard**: An experimental analysis of the origin and relationship of blood corpuscles and the lining cells of vessels. Vascular endothelium erythrocytes and leucocytes, although all arise from mesenchyme, are really polyphyletic in origin; that is, each has a different mesenchymal anlage.

BOOKS RECEIVED.

Scientific Ideas of To-day. By C. R. Gibson. Fifth edition. Pp. 344. (London: Seeley, Service and Co., Ltd.) 5*s*. net.

Mathematics for Machinists. By R. W. Burnham. Pp. viii+229. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 5*s*. 6*d*. net.

Determinative Mineralogy, with Tables for the determination of Minerals by Means of their Chemical and Physical Characters. By Prof. J. V. Lewis. Pp. vii+155. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 6*s*. 6*d*. net.

Properties of Steam and Ammonia. By Prof. G. A. Goodenough. Pp. vii+108. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 5*s*. 6*d*. net.

Wisconsin Geological and Natural History Survey. Bulletin No. xlv. Economic Series. No. 20: The Peat Resources of Wisconsin. By F. W. Huels. Pp. xvii+274. (Madison, Wis.)

Tuberculosis: a General Account of the Disease, its Forms, Treatment, and Prevention. By Dr. A. J. Jex-Blake. Pp. viii+231. (London: G. Bell and Sons, Ltd.) 2*s*. 6*d*. net.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 25.

ROYAL SOCIETY, at 4.—Special General Meeting to receive the Annual Report of Council: at 4.30.—The Measurement of the Rate of Heat Loss at Body Temperature by Convection, Radiation and Evaporation: M. Flack, O. W. Griffith and L. Hill.—The Growth of the Body in Man; The Relationship between the Body Weight and the Body Length (Stem Length) E. W. A Walker.—The Rate of Absorption of Various Phenolic Solutions by Seeds of *Hordeum vulgare* and the Factors Governing the Rate of Diffusion of Aqueous Solutions across the Semi-permeable Membranes: Prof. A. J. Brown and F. Tinker.—The Controlling Influence of Carbonic Dioxide. Part III. The Retarding Effect of Carbon Dioxide on Respiration: F. Kidd.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Some Difficulties of Design of High-speed Generators: Prof. A. B. Field.

OPTICAL SOCIETY, at 8.—The Influence of Visual Errors in Musketry: J. H. Sutcliffe.

FRIDAY, NOVEMBER 26.

PHYSICAL SOCIETY, at 5.—Obtaining and Maintaining a Bright Hydrogen Spectrum, with special reference to the 4341 Line: J. Guild.—Determination of the Coefficient of Diffusion of Potassium Chloride by an Analytical Method Dr. A. Griffiths.—Apparatus for Evaluating Elliptic Integrals: A. F. Ravenshear.

MONDAY, NOVEMBER 29.

ROYAL SOCIETY OF ARTS, at 4.30.—Optical Glass: Dr. W. Rosenhain.

MEDICAL SOCIETY, at 8.30.—Gas Poisoning: Physiological Symptoms and Clinical Treatment: Dr. Leonard Hill.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—The Railway Development of Africa, Present and Future: Sir Charles Metcalfe, Bart.

TUESDAY, NOVEMBER 30.

ROYAL SOCIETY OF ARTS, at 4.30.—Recent Developments in Jamaica: Internal and External: Sir Sydney Olivier.

INSTITUTION OF CIVIL ENGINEERS, at 5.30.—Harbour and Coast-Defence Works at Alexandria: D. E. Lloyd-Davies.—Galvan Port, Bahia Blanca, Argentine: C. A. Trery.

WEDNESDAY, DECEMBER 1.

ROYAL SOCIETY OF ARTS, at 4.30.—Insects and War: Dr. A. E. Shipley.

GEOLOGICAL SOCIETY, at 5.30.—The Petrological Microscope; New or Little-known Methods and Accessories: Dr. J. W. Evans.

ENTOMOLOGICAL SOCIETY, at 8.

SOCIETY OF PUBLIC ANALYSTS, at 8.—The Microchemistry of some Alkaloids: Dr. G. D. Lander.—The "Presumptive Coli Test" on Unchilled Water: W. Partridge: Notes on Methods of Analysing Oleaginous Seeds and Fruits: E. R. Bolton.

THURSDAY, DECEMBER 2.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* Note on the Existence of Converging Sequences in certain Oscillating Successions of Functions: W. H. Young.—The Emulsifying Action of Soap; a Contribution to the Theory of Detergent Action: S. A. Shorter and S. Ellingworth.—The Newtonian Constant of Gravitation as affected by Temperature: P. E. Shaw.—Skin Friction of the Wind on the Earth's Surface: G. I. Taylor.

FRIDAY, DECEMBER 3.

GEOLOGISTS' ASSOCIATION, at 7.30.—Some Features of the Antarctic Ice: J. D. Falconer.

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THURSDAY, DECEMBER 2, 1915.

WORK AND WORTH.

THERE has been much discussion recently as to ways and means of national economy. We referred to the matter a few weeks ago in connection with a circular issued by the Treasury in which it was suggested that all vacancies in universities and like institutions of higher education should be left unfilled, and that some institutions and departments should be closed, so that members of the staffs could be set free to seek other employment and relieve the institutions of the payment of their salaries. All of us are in sympathy with the efforts being made to reduce unproductive expenditure of public moneys, but grants for purposes of higher education and research can scarcely be placed in this category; and it is characteristically British that they should come in for early attention at the present juncture. The University of London is to drift along without a Principal, and vacant scientific chairs are to remain without occupants, though since the war three new judges have been appointed with salaries of 5000*l.* each, and a Lord Chancellor's secretary at a salary of 2000*l.*

A correspondent of the *Times* points out, in addition, that the salary of the Lord Chancellor is 10,000*l.* per annum, and that there are three ex-Lord Chancellors receiving pensions which amount to 15,000*l.* per annum, and six Law Lords with total salaries of 36,000*l.*, as well as several ex-Judges. The position of the Attorney-General is said to be worth some 20,000*l.* per annum, and that of Solicitor-General about 18,000*l.* No attempt seems to have been made on the recent appointments to curtail the remuneration of these officials, who, with other Ministers, absorb about 120,000*l.* annually in salaries, but professorial posts with salaries of 600*l.* a year or so are to remain unfilled, and many holders of these and lesser positions in our educational institutions have agreed to let their salaries be reduced by 10 per cent. or more in order to effect economies. Can anything be said in justification of the disparity of treatment thus given to men who are discovering the laws of nature in comparison with those who are concerned with the laws of the land?

The necessity to economise has been impressed upon the governing bodies of all university and technical institutions on account of loss of income from fees and other sources in consequence of the war. Notwithstanding the reduction of staffs and salaries, these institutions are in most cases faced with serious deficits, which are likely to increase, and will in many cases prevent the continuance of valuable work. Not only most of the students, but also a high proportion of the members of the staffs of military age, are on active service or in training for his Majesty's Forces. Those who remain are mostly not eligible for such service, or are engaged upon work of direct value to the country in its present emergency. The reduction in the number of students has enabled members of the scientific and engineering staffs of universities and colleges to undertake national work to an extent which would have been impossible under normal conditions of instruction. Every laboratory in the country has been at the disposal of the Government, and the services of experts in science and technology in university institutions have been utilised for training munition workers and undertaking tests and inquiries of military significance.

While commercial agents connected with the supply of war materials are receiving tens of thousands of pounds as commission for effecting business between manufactories and war markets, while substantial salaries are demanded for legal talent, whatever the country's need may be, and medical consultants accept retaining fees for their expert advice, men of science of equal eminence in their particular spheres of work give their special knowledge freely to the State; and they are glad of the opportunity of thus showing their patriotism. None of the scientific men working on war problems in connection with committees of the Royal Society and other scientific societies receive any payment from the societies. The Munitions Inventions Department of the Ministry of Munitions has an advisory panel of twenty-six scientific and other experts who are certainly among the leading representatives of applied science in this country; yet the Comptroller informs us that these gentlemen are not paid, and that their services are in all cases voluntary. This is true also of the central committee and the panel of consultants of the Board of Invention and Research connected with the Admiralty. No payment is asked for or given, though the financial value of the expert knowledge which these committees and panels of consultants have brought to bear upon national problems must be very great. Let us hope that the voluntary services thus rendered cheerfully, in order to make our armed forces more effective, will not be forgotten when provision for instruction and research in institutions of science and technology is under consideration by administrators of State funds.

Voluntary work should be expected of all classes in these times; but it is unfortunately true that such services are expected of science at all times. Scientific men have themselves largely to thank for the low financial value placed on their services. They are ready to work for little or nothing, especially if the task offers opportunity for research; and in a business world, which assesses expert knowledge by the fees it can command, takes them at their own low valuation. They accept pittances from governing bodies of universities and technical institutions which would not be offered to any other professional men of like standing. They sign agreements not to undertake paid outside work, though such work is often the surest means of keeping science in touch with problems of industry, and they are willing to give valuable information as to scientific materials and processes to manufacturing firms which are rich enough to pay handsomely for the advice. University authorities, business men, and the Government all exploit the scientific worker, who is so much taken up with his individual studies that he is content to consider science as its own reward, and to let anyone who cares derive profit from his knowledge.

Personal reward—as the world understands it—for work done or results obtained is the last thought of a student of science. "I have no time to make money," was the reply of Louis Agassiz to an offer to lend himself to a legitimate and tempting financial scheme. A like remark was made by Pasteur to Lady Priestley, "I could never work for money, but I would always work for science." Yet, according to Huxley, Pasteur's work for the prevention of anthrax, silkworm disease, and chicken cholera added annually to the wealth of France a sum equivalent to the entire indemnity paid by France to Germany after the war of 1870. If Pasteur had chosen to keep his discoveries to himself, he could have been one of the most wealthy men in the world, but he gave them to the human race, and was content to end his career as a professor of chemistry in receipt of a modest salary from the Government of his country. Most scientific work is done without expectation of reward. The man who devotes himself to the advancement of knowledge is continually finding himself without the means of obtaining the instruments or other material necessary for the pursuit of his researches. He has to carry out a fair amount of work successfully, and to use his own limited resources for it, before he can hope to secure a portion of the modest grants in aid available.

When men of science ask for funds for scientific research they do not wish to bury the talents they receive or to derive personal profit from them. Whatever amount is entrusted to them is returned a hundredfold in the results achieved. How many are the researches worthy of assistance, and how small are the funds available for investigations having no obvious practical application, are understood only by men of science themselves. It would be a revelation to people endowed with a larger share of worldly riches to be present at a meeting of the Committee of Recommendations of the British Association when the allocation of grants for scientific purposes is being made. A score or so of the leading scientific men in the British Isles debate for two or three hours how to divide the sum of about 1000*l.*, which represents the amount available from the sale of tickets at the annual meeting. There are many applications for grants from committees of each of the twelve sections of the Association, and the amount required has usually to be whittled down to 5*l.* or 10*l.*, which often does not cover the expense of stationery and postage of a research committee. Not one penny goes into the pockets of the men who are conducting the researches, yet claim after claim has to be passed, or reduced to its lowest limits, because the fund is far too small to meet the demands made upon it.

Prof. T. B. Robertson suggests in the *Scientific Monthly* for November that a certain proportion, no matter how small, of the wealth which science pours into the lap of the community should return automatically to the support and expansion of scientific research. "The collection of a tax upon profits accruing from inventions (which are all ultimately if indirectly results of scientific advance), and the devotion of the proceeds from this tax to the furtherance of research, would not only be a policy of wisdom in the most material sense, but it would also be a policy of bare justice." Prof. Robertson points out that the value of the electrical machinery, apparatus, and supplies produced in the United States alone in 1909 was 44,200,000*l.* In 1907 the value of the electric light and power stations in the same country was 219,400,000*l.*, of the telephones 164,000,000*l.*, and the combined income from these two sources was 72,000,000*l.* Nor do these sums represent a tithe of the values which Faraday's researches on electromagnetics have placed at the disposal of the world, which, while accepting the riches, has not returned one millionth or a discernible fraction of the wealth for the continuance of research. Faraday de-

liberately devoted his life to the increase of natural knowledge rather than the pursuit of wealth, and the community has been content to reap the benefits of his discoveries without any sense of responsibility as to payment for them.

The question of payment for scientific researches is raised by Sir Ronald Ross in *Science Progress* for October in a note headed "Mr. Lloyd George, the Nation of Shopkeepers, and the Pied Piper of Hamelin." We are very glad that Sir Ronald Ross has made formal application to the Government for a subsidy in recompense for the work which he has accomplished in connection with tropical medicine. We are not surprised that his application has been refused; at the same time he has done good work in directing attention to the absence of any provision for such compensation. It is true that we have Civil List pensions, but, as he points out, these are quite inadequate, and, moreover, partake largely of the nature of charities. The precedent of Jenner shows that the Government did actually vote a grant of money to the pioneer of preventive medicine, but this was many years ago, and Mr. Lloyd George's secretary informed Sir Ronald Ross that such a recommendation was not in accordance with modern usages. Thus while large salaries are paid to political officials, the man who is capable of conferring the greatest benefits on mankind is passed over. He has either to lose the income which he might otherwise earn, or to leave undone most or all of what he ought to have done. If he adopts the first alternative he will not be able to work at his proper efficiency. The nation is calling out for more and more scientifically trained men, but when it has produced them the payments offered for their services as teachers are deplorably low, and beyond these there is little hope of further reward, whatever the national worth of their work. We look for the coming of the time when the State will take the lead in showing juster appreciation of the men who are extending and organising the knowledge upon which modern advance depends.

RECENT DEVELOPMENTS IN CHEMICAL TECHNOLOGY.

Manuals of Chemical Technology. II. The Rare Earth Industry. By S. J. Johnstone. Together with a chapter on The Industry of Radio-active Substances. By Dr. A. S. Russell. Pp. xii + 136. (London: Crosby Lockwood and Son, 1915.) Price 7s. 6d. net.

Manuals of Chemical Technology. III. Industrial Nitrogen Compounds and Explosives. By Dr. G. Martin and W. Barbour. Pp. viii + 125. (London: Crosby Lockwood and Son, 1915.) Price 7s. 6d. net.

THESE volumes form part of a series of manuals of Chemical Technology which is being produced under the editorship of Dr. Geoffrey Martin. The series consists largely of compilations, each extending to about 120 octavo pages, suitably illustrated (where illustrations are available) with process cuts, and provided with fairly full bibliographies and references to original sources of information. But it must be obvious that in such limited space there is not much room for descriptive letterpress or for detailed accounts of technical methods.

In this respect, therefore, the manuals compare unfavourably with standard treatises designed primarily as works of reference, and for the information of actual manufacturers. At the same time, certain of the books in the series may be said to have a special value at this present juncture, when the future of chemical manufacturing in this country is so dark and so full of anxiety. It is quite certain that, in the fierce industrial struggle which will follow the cessation of hostilities, we shall be confronted with new difficulties and dangers. There will be a gigantic effort on the part of our present enemies not only to reacquire the markets which have now been practically closed to them for upwards of a year, but also to wrest from us our pre-eminence in certain branches of manufacturing chemistry—limited in number but large in output—which we have been accustomed to regard as among our staple industries.

Leaders of chemical technology in Germany openly declare their intention to bring all their powers of organisation and their manifold resources—educational, industrial, and financial—to bear upon the realisation of this consummation. The struggle will be all the keener, and tell more hardly against us, from the circumstance that much of the economic advantage we have hitherto enjoyed will be greatly curtailed, and it is possible that nothing short of a revolution in our fiscal policy will be required to maintain what is left of it. No doubt our competitors, like ourselves, have their labour problems, but it is doubtful whether these have reached the acute stage that we witness in this country. There would seem to be nothing like that deep-rooted antagonism between labour and capital in Germany that we are painfully conscious of, and which has made itself so deplorably evident, even at a time when our very existence as a nation is at stake. The combination which the largest, richest, and most powerful of our trade unions—all concerned

in those fundamental industries upon which our national prosperity ultimately depends—have recently succeeded in effecting among themselves is ominous of impending revolution—to break out, it may be, when the time of inflated wages comes to a stoppage and when the country is suffering from the industrial depression which inevitably awaits it.

Anything, then, which tends to open our eyes to fresh possibilities and new departures in production is to be welcomed. Hitherto our main chemical industries have been on too restricted lines. Our manufacturers have mostly confined their efforts to the limited class of products known as "heavy chemicals," and have paid little heed to the production of many things which modern civilisation and recent industrial development requires. It is a notorious fact that with us the application of organic chemistry to chemical industry has been painfully slow, and it is very problematical whether we shall ever succeed in regaining a position which at one time was well within our grasp if our manufacturers had possessed the perspicacity, knowledge, and skill required to retain it. But even in many of the newer applications of inorganic chemistry to industrial pursuits we have let slip opportunities which a little energy, enterprise, and foresight might have secured.

Mr. Sydney Johnstone's monograph on "The Rare Earth Industry" affords a striking illustration of this fact. We were the pioneers in gas lighting, but Carl Auer's discovery, twenty-five years ago, of the effect of certain "earths" in enhancing the illuminating power of a gas flame, was to us as seed falling by the wayside. Certain of our men of science, notably the late Sir George Stokes, attracted by the remarkable phenomena which Auer von Welsbach's discovery revealed, probably recognised, and in other circumstances might even have succeeded in making more generally known, the possibilities that were latent in it. But Stokes moved in an orbit in which manufacturers as a class never enter. Such is the gulf existing in this country between science and industry that probably not one in a hundred of them had even heard of his existence. He was as far removed from them, in fact, as an archangel from an apothecary—or at least that type of apothecary whose chief concern is with an "effective window display" and the profits of "leading side-lines."

We have prided ourselves in the past on being pre-eminently industrial inorganic chemists, but until quite recently practically the whole of the thorium nitrate required for the world's consumption of gas-mantles was made in Germany. German financial houses acquired control of the Brazilian output of monazite, and German chemists worked out the methods of extraction of thoria. Important deposits of monazite, containing twice as much thoria as the Brazilian mineral, are found in southern India, particularly in Travancore. Prior to the war, practically the whole of the exported product found its way to Germany, although India is a British possession. More recently France and the United States have entered the lists against Germany, but comparatively little thorium nitrate seems to be made in this country. And yet the total consumption of incandescent mantles is stated to be 300 millions per annum, of which, in 1913, the United Kingdom imported to the value of 302,576*l.*

As Mr. Johnstone points out, the term "rare earth," as applied to ceria and thoria, is now a misnomer, as these substances, together with certain of the earths associated with them, are now obtainable in larger quantities and at a cheaper price than many compounds of the so-called "common" elements. The extraordinary development of the new industry may be gathered from the fact that, whereas the cost of thorium nitrate in 1894 was 100*l.* per kilo, its price in the United Kingdom in June, 1914, was 18*s.* per kilo.

The account of the thorium and cerium industry, including the manufacture of incandescent mantles and pyrophoric alloys, occupies above one-third of the book under review. Most of the remainder is concerned with the industrial uses of titanium, zirconium, tantalum, columbium (which the author miscalls niobium), and tungsten, to which is appended a short description of the incandescent electric glow-lamp industry. There are a few pages relating to the economic uses of uranium and vanadium, and Dr. Alexander S. Russell contributes a concise account of the present state of the industry of radio-active substances. The authors have succeeded in putting together a most interesting monograph on matters to which the ordinary text-books have hitherto done scant justice. Their work affords a valuable object-lesson of the potentialities which may exist in even the most recondite of chemical subjects.

The volume on "Industrial Nitrogen Compounds and Explosives," by the editor and Mr. Barbour, is scarcely commensurate with the large and important theme with which it deals. It is utterly impossible to deal adequately in the space assigned with so comprehensive a subject as that which includes the nitrate industry, the manufacture of nitric acid, ammonia and ammoniacal salts, synthetic ammonia, the cyanamide industry, the production of cyanides and prussiates, and

the manufacture of modern explosives. The treatment, therefore, is only of the slightest, and consequently the work is of little practical value to the technologist, except as regards its bibliography and patent-lists. At the same time, it is of interest to the general reader or the student who wishes to gain an acquaintance with the characteristic features of some of the latest triumphs of applied chemistry, such as the utilisation of atmospheric nitrogen and the synthesis of ammonia and nitric acid—new industries which are said to have rendered Germany independent of external supplies of nitrates as raw materials for the manufacture of explosives, and which, whatever be their present position, are ultimately destined to effect a revolution in chemical industry.

The work, therefore, from its very incompleteness, is necessarily only of passing interest, but as an essay *pour servir* it may be commended to those who, for any reason, are satisfied with a superficial knowledge of the vast and enormously important subject of which it treats. T.

ALLIGATORS.

The Alligator and its Allies. By Dr. A. M. Reese. Pp. xi+358. (New York and London: G. P. Putnam's Sons, 1915.) Price 10*s.* 6*d.* net.

PROF. REESE, of West Virginia University, is best known as an embryologist, and the author of a memoir on the development of *Alligator mississippiensis*, published a few years ago in the Smithsonian Miscellaneous Collections, a reprint of which, with slight additions, forms about one-fourth of this book. When hunting for embryological material in the swamps of Florida the author has had many opportunities of studying the habits of the alligator, and his interesting observations are embodied in the chapter entitled "Biology of the Crocodilia." The chapters on the skeleton and on the nervous system are partly, those on the digestive, urogenital, respiratory, and vascular systems mainly, by the author. The description of the muscular system is a translation from the account in Bronn's "Thierreich," which is here and there quoted as the work of Bronn himself, the fact being apparently overlooked that Prof. H. G. Bronn, the founder of the well-known zoological encyclopædia, "Die Klassen und Ordnungen des Thierreichs," was a palæontologist who never busied himself with reptiles, and died fully ten years before the reptilian section was taken in hand by Prof. C. K. Hoffmann, whose name is not even quoted in the very carelessly compiled bibliography at the end of the book under review.

A treatise of this kind must naturally be to a certain extent a compilation, but it is regrettable that more care should not have been exercised in selecting matter, and that the author should not have drawn directly from the best sources instead of taking so much at second hand. As an example, we would point out that the map of the present distribution of crocodilia, copied from the "Cambridge Natural History" is inaccurate in one respect of first importance from the American point of view, viz., in the omission of crocodiles from Florida, where they are well known to exist in addition to alligators, as the author himself admits on the very same page. Further, the book might have been made far more useful to the wide circle for which it appears to be intended by comments on the bearing of the facts recorded on various zoological problems, such as phylogeny, ethology, zoogeography, etc. Why, for instance, is the question "ancestry" skipped over in a few meaningless words, when quotations from Huxley's classical memoir, only mentioned in the bibliography, and from the numerous recent publications on Triassic reptiles, could have been interwoven to make an interesting and instructive chapter? The fact that the egg of the alligator is laid containing an embryo, often of considerable size, surely might have been the opportunity for a brief allusion to the question of viviparous and ovoviviparous reptiles and to the intermediate degrees known to connect the latter with the normal state in various lizards and snakes.

There was no necessity, in a book like this, to enter into details on the various species of crocodilians, but, as the subject has been included, there is no excuse for leaving out four of the most interesting types, viz., the Malay False-gharial, *Tomistoma schlegelii*, the gharial-like crocodiles, *Crocodilus cataphractus* and *johnstonii*, and the alligator-like *Osteolaemus tetraspis*.

G. A. B.

PLANE SURVEYING.

Surveying and Field Work: A Practical Text-Book on Surveying, Levelling, and Setting-out. By J. Williamson. Pp. xxii+363. (London: Constable and Co., Ltd., 1915.) Price 7*s.* 6*d.* net.

IN a very practical work the author gives a comprehensive account of the methods employed in the measurement of the earth's surface when comparatively small areas are concerned, so that the portion dealt with may be considered as being a horizontal plane.

Chain-surveying is fully described, and is conveniently used to introduce the beginner to the

various operations which result finally in the finished map or plan. A valuable feature of the book is that the accuracy attainable in an operation is clearly stated, and the surveyor is taught to plan his work according to the accuracy which the purpose that it is to serve demands, while not attempting such a degree of precision as would lead to an expenditure of time and money which would not be economical under the conditions existing. In this connection a little more might, perhaps, be said on the selection of the scale of maps as determined by the permissible errors of the work and the limitations of the draughtsman. A short account of the theory of errors and its application to survey measurements would also seem to fall within the scope of this text-book.

The theodolite and its adjustments are fully dealt with as regards vernier instruments, since those fitted with micrometer microscopes are considered to belong to the more precise work of higher surveying. At the same time, it may be questioned whether the simpler forms of microscope which are in use abroad are not both more easy to read and less liable to injury than the vernier.

The execution of a small triangulation, in which plane trigonometry only is required, furnishes an instructive example of the various operations involved, base measurement, selection of stations, and measurement of angles, and these are discussed with special reference to the errors which are liable to occur, and the limits within which they may be expected to fall.

Levelling with the spirit-level is dealt with in the same detailed manner, and a simple formula is given to guide the leveller in judging of the accuracy of his work.

In the chapter on the calculation of areas, the more modern patterns of planimeter might be mentioned, since with them the instrumental error can be eliminated from the result by changing the position of the fixed point and repeating the measurement; also a convenient check on the accuracy of the measurement is provided. A reference to the slide rule, and to computing machines, computing table, etc., would be of value as indicating to the surveyor ways in which he may save time in his work.

The tacheometer is not mentioned, since it is probably considered as more suited for topographical surveys, but in many countries it is largely employed in preliminary surveys and in much large scale work.

Theoretical accounts of most operations are given, and these might even be extended with advantage, since they indicate clearly the directions in which errors are to be anticipated, and the conditions under which they tend to increase in magnitude.

The book is well illustrated and contains numerous practical examples, which have been well chosen with the view of showing such cases as may be expected to occur in ordinary practice.

H. G. L.

OUR BOOKSHELF.

Unit Photography. By F. M. Steadman. Pp. xi + 160. (London: Constable and Co., Ltd., 1914.) Price 8*s.* 6*d.* net.

THE author deplores the "whole train of lamentable conditions in photography relative to exposure," and sets himself "to establish a rational scientific foundation for the practice of photography and for the study of light as it is daily observed in nature." He says that the apertures of lenses, the sensitiveness of emulsions, and the chemical energy of lights lack simple units of measurement, and that therefore photography is not scientifically practised. He adopts $f/64$ as the unit for lens apertures, calling the figures which represent the intensities of the ordinary apertures up to $f/1$ the "cone unit values." His standard of "actinicity" is "that rate of emission which will produce a least visible tint in one minute (or 64 seconds) when the convergence is $f/1$ (or 4000 cone units)." This is an "actino." "The speed of an emulsion is defined as the time required for it to suffer an effect which is known as normal exposure, when it is exposed to a surface having an intensity of one actino and through a diaphragm having a convergent value of one cone unit." He gives full instructions for the use of these standards, and works out a number of problems that will prove of much interest to the curious. His "$f/1$ actinometer" is a box which has an opening equal in diameter to its distance from the opposite side, where a piece of sensitive paper is placed. The first experiment suggested in "unit actinometry" is to measure or estimate the average diameter of a flame, put the sensitive paper at a distance of two diameters ($f/2$) from it, and time the period necessary to produce the first visible effect. The calculation as explained gives "the average intensity of the flame in actinos."

The volume contains useful suggestions, though we cannot see that the methods propounded are any more "scientific" than the ordinary procedure with commercial exposure meters, and we distinctly differ from the author in his idea as to the "lamentable condition" of photography with regard to exposure, so far as this country is concerned. It may be different in America.

The Student's System. By V. Russell. Pp. 113. (London: J. M. Dent and Sons, Ltd., 1915.) Price 1*s.* 6*d.* net.

THIS book advocates the use of a loose-leaf notebook by University students, and by all who are engaged in study or research. It is claimed that, by adopting this system, a student need not carry

more than one notebook into his various classrooms, because, provided he is careful to turn over the page when he comes to a new subject, he can take out the loose leaves at his leisure and sort them into suitable receptacles. A student will also find as he pursues his study that he acquires further information supplementing his previous notes. By writing upon loose leaves he will be able to sort the new matter into its proper place.

Conscientious students are inclined to waste much time in making a fair copy of the notes they have taken at lectures: such copying often becomes mechanical, so that nothing is learnt during the process. The loose-leaf method should make this mechanical work unnecessary, at all events when the original notes are intelligible.

The loose leaves relating to any given subject should be so arranged as to make reference easy. For this purpose the author gives several examples of classification in which registration letters and numbers are employed. As to the significance to be given to these letters and numbers, we would advise the student to consult one of the comprehensive works of reference, such as, in the case of science, the International Catalogue of Scientific Literature, and to adopt, so far as possible, the plan there set forth.

An Historical Atlas of Modern Europe from 1789 to 1914, with an Historical and Explanatory Text. By C. G. Robertson and J. G. Bartholomew. Pp. 24+36 maps. (London: Oxford University Press, 1915.) Price 3s. 6d. net.

THIS is an atlas on new lines, for it deals only with modern Europe, and, except for a few general maps, makes no attempt to illustrate the historical evolution of the British Empire. The size of the atlas is a distinct advantage, as it allows of plates $12\frac{1}{2}\times 9\frac{1}{2}$ in. Most of the maps are of this size. Central Europe and the Balkan lands are specially well shown, as would be expected, but we miss a separate map of the Iberian peninsula. No doubt, however, the question of expense entailed the omission of the less necessary maps.

A map of Europe is the only orographical map given. The other maps either show no relief or show it in the old caterpillar fashion. That is disappointing, and certainly lessens the value of the larger-scale maps. There is, of course, a difficulty in showing relief by contours on a map with political colouring, but that might be overcome in many plates by omitting the political colouring and indicating boundaries by red lines. Most of the plates are otherwise admirably executed, but a few—Russia in Central Asia and the ethnographical map of south-eastern Europe—scarcely come up to the high standard of technique which we expect from the firm of Bartholomew.

The introduction is an excellent commentary on the maps, and keeps the geographical standpoint in view throughout. The atlas is good value for the money and can be highly recommended.

R. N. R. B.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

A Question of Albedo.

THE past summer in the Kashmir Valley has been one of extraordinary dryness, with continuous blue skies and hot sunshine. These conditions have extended into the autumn, and during the month of October even the surrounding mountains, so often clouded, have been entirely clear. The snow-line, instead of descending to lower elevations with the advance of the season, has steadily risen, until at the date of writing only a few isolated patches of white can be seen on the Pir Panjal range on the south-west side of the valley, and no snow at all on the mountains towards the east. It was with a distinct shock of surprise, therefore, that at sunset on the date October 22 we noticed a beautiful dome of snow just topping the eastern mountains, which were still brilliantly illuminated by the sun. For a few moments the only possible explanation seemed to be that one of the higher peaks of the central Himalayan ranges had made a prodigious upward thrust of several thousands of feet! However, the earth's rotation movement rapidly transformed this snowfield into the familiar features of the full moon.

The question I would ask is: Why does the moon appear so white if it is composed of rocks similar in reflecting power to those on the earth? The average albedo of the moon must have been determined, and it is no doubt well known how it compares with Venus or with Jupiter when these are reduced to unit distance from the sun. The rock surface of the moon should reflect far less light than the cloudy surfaces of these planets, and it would be of interest if those who know would explain the apparent whiteness of the moon as seen in daylight.

A direct comparison of the moon with terrestrial rock surfaces illumined by sunlight is possibly to some extent vitiated by the superposed blue light scattered by the intervening air, which may affect the colour of the moon. Yet it is very difficult to believe that this can convert the greys and browns of rock surfaces into an almost pure white. On several occasions in this valley I have compared the waning moon, setting behind the Pir Panjal mountains, and, of course, in full sunlight, with extensive snowfields. These snows are perhaps fifty miles distant, and there is a considerable amount of blue scattered light superposed on the snow, although less than on the moon; also the light absorbed by the atmosphere is approximately, and may be exactly, the same for each, if one considers the whole path of the light from sun to snow and thence to the observer. When the air is transparent enough to see the moon clearly, it appears to me to be distinctly whiter than the snows, which seem dull and yellowish in comparison.

The daylight colour of the moon suggests, in fact, that Parmenides was right when he considered it to be composed of earthy material mixed with celestial fire, only I should say that the celestial fire greatly predominates!

One does not hear much nowadays of the glacial theory of the moon's surface, but it would be interesting to learn whether the daylight aspect of the moon has been considered by those who believe its surface to be composed of rocks. J. EVERSHED.

Srinagar, Kashmir, November 2.

Duty-Free Alcohol.

A SHORT time ago some letters on this subject appeared in NATURE, complaining of the difficulties experienced by scientific workers in obtaining permission to use such alcohol, and of the absurd regulations accompanying such permission. Perhaps the complainants, amongst whom, I remember, Sir William Ramsay was one, were somewhat unreasonable, for they should have considered that the officials in the Excise Department, as in other Government departments, are mostly of the "kings and captains" type; they really do not know what a laboratory or scientific work means; they certainly do not know what distillation implies, and probably their only idea as to alcohol is that it is something which is always either under- or over-proof, like the old lady's idea of stocks and shares, as being those things which go up and down in the City.

I was lucky enough to obtain permission to use duty-free alcohol, though only after long negotiations, and on the explicit assurance that I would not use it for running motor omnibuses round my laboratory. But recently the need for economy induced me to apply for permission to recover my waste spirit by distillation. After the usual six weeks' delay, and sheaves of official documents, an officer was sent to examine my stills, and was shown several shelves of retorts and flasks; but on my explaining to him that not more than one of these would be in use at the time for the purpose in question, we filled in the form of application for one still of about a litre capacity to be used in redistilling alcohol: and a permit for doing so eventually reached me. But in the course of the next few months the transaction had permeated to the domain of some higher official, whose eagle eye detected a flaw. Was I using a condenser in this distillation, and, if so, how many, and with what object? Again the official visited me, and was shown three condensers in a dusty corner of the laboratory: so the form of application was altered accordingly; and I am now the proud possessor of full official permit, granted "as an indulgence," to use in my laboratory a still of not more than quarter-gallon capacity with three Liebig condensers. SPENCER PICKERING.

Standards and Functions of Museums.

"W. P. P." is in error in his article on the "Standards and Functions of Museums," which appeared in NATURE for September 23, when he says that the Department of Public Health in the American Museum of Natural History answers to no more than one aspect of the Department of Economic Zoology of the British Museum of Natural History, that which concerns the organisms injurious to man.

The Department of Public Health does cover more than this; the exhibits so far arranged come under the following heads: water supply, sewage disposal, bacteria and bacterial diseases, insect-borne diseases, and military hygiene; while the exhibits in course of preparation deal with problems of diet. Especial stress naturally has been placed upon the bubonic plague, malaria, and yellow fever, as well as on the sanitation of the Panama Canal zone. Other aspects of the relations of insects to man are treated in the exhibits of the division of entomology, such as the importance of insects, benefits due to insects, and injuries caused by them. There is no collection of domesticated animals other than that illustrating variation under domestication, and, owing to lack of funds and space, no attempt can be made to bring together such a collection. F. A. LUCAS.

American Museum of Natural History,
New York, October 19.

DR. LUCAS's brief summary of the ground covered by the Department of Public Health in the American Museum of Natural History is more complete than that which appeared in the forty-sixth annual report of the museum, which formed the subject of the article against which Dr. Lucas now lodges his protest; hence the "error" of the writer. We contend that only by a very elastic use of the term "Natural History Museum" can such subjects as the disposal of sewage, and water supply, be included. These are surely more fittingly themes for a Museum of Technology, while military hygiene and problems of diet would find a more suitable home in a Museum of Physiology. If these were omitted the funds and space which they absorb would be available for the collection of domesticated animals which Dr. Lucas is now obliged to neglect, to the great hurt of his museum.

W. P. P.

Multiple-Character Evolution.

ONE should have thought that a meeting of the Palæontological Society of America was scarcely a propitious occasion for promulgating as a newly discovered law that a body equals the sum of all its parts. As your reviewer has rightly remarked (NATURE, p. 286), it has been said before that every organism is made up of a great number of characters, each of which is in a state of flux. The obvious fact that any species has more than one differential character (of which we use only those which take our fancy) never had need of rediscovery, but it has occasionally been neglected, merely not thought of, sometimes with appalling consequences, as, for instance, it has been solemnly pleaded that if one character distinguishes a species, two should make a genus. H. GADOW.

Zoological Laboratory, Cambridge,
November 26.

EGYPT AND THE FAR EAST.[1]

PROF. ELLIOT SMITH has long established his position as our principal authority on the anatomical study of ancient Egyptian mummification. Before he undertook the systematic examination of mummies during the years he spent in Egypt, the vaguest and often the most erroneous notions were current with regard to the technical treatment of the corpse and its intestines by the ancient Egyptian embalmers. To the average Egyptologist such details necessarily appeared of a rather gruesome character, and, as a consequence, Prof. Elliot Smith, who brought expert medical knowledge to bear on an unrivalled collection of material, was able to obtain important results in what to all intents and purposes was a virgin field of research. His volume of the Cairo Catalogue, which was reviewed in NATURE on its publication, marked, as was pointed out at the time, a fitting culmination to his labours. When, therefore, its author has anything to tell us in connection with the subject he has made peculiarly his own, he is entitled to more than a respectful hearing. If on some essential

[1] "On the Significance of the Geographical Distribution of the Practice of Mummification. A Study of the Migrations of Peoples and the Spread of certain Customs and Beliefs." By Prof. G. Elliot Smith. From vol. lix., part ii, of Memoirs and Proceedings of the Manchester Literary and Philosophical Society, Session 1914–15. Pp. 143. (Manchester: 36 George Street, 1915.) Price 2s. 6d.

points we are inclined to reserve judgment, it is because his theory opens up a number of collateral problems which demand independent examination. But there can be no doubt that the theory as he propounds it is very attractive, and it has the advantage of ranging over a number of detached and separate fields of study. Even for those who may not go quite so far as to believe with him that the influence of ancient Egypt ever spread to the Far East and to America, it is well to re-examine the grounds for scepticism, and, in the process, to take perhaps a less restricted view of the possibilities of intercourse in the ancient world.

The present monograph is the direct outcome of a paper read before the Anthropological Section at the meeting of the British Association last year in Melbourne. At the three preceding meetings its author had already developed his thesis that the geographical distribution of certain practices, such as mummification and megalithic building, point, on his view of the evidence, to their distribution from a common centre somewhere in the neighbourhood of the eastern Mediterranean. When setting out for the Australian meeting it had been his intention to develop his argument from megalithic monuments, while using the geographical distribution of the practice of mummification merely as a subsidiary means of corroboration. But on his arrival at Sydney he examined the mummy from Torres Straits in the Macleay Museum, and studied the literature relating to the methods of embalming in that region; and, as a result, he formed the conclusion that the methods employed in the Papuan mummies must be of Egyptian origin. Moreover, since the practices which he there noted were not prevalent in Egypt until the time of the New Empire, and some of them not until the time of the XXIst Dynasty, he further concluded that they could not have left Egypt on their long journey to the Torres Straits at the earliest before the ninth century B.C.

The work before us was written as an answer to one of the criticisms of the theory at the British Association meeting, to the effect that there were no links between Egypt and Papua to indicate that the custom of mummification had spread from the one region to the other. Prof. Elliot Smith here replies that there are plenty of links; and he works out the course of a great culture-migration, which, he suggests, began a world tour from Egypt, and, coasting eastward to India and Ceylon, was carried far out into the Pacific, and eventually reached the American continent. There is, of course, no continuous chain of mummification customs, or even of megalithic monuments, on which this world-wide theory may rest; but traces of the migration, deduced from common distribution, are said to be visible also in sun-worship, serpent-worship, the tradition of a world-wide deluge, petrifaction myths, the use of the swastika emblem, and the practices of ear-piercing, tattooing, couvade, the artificial deformation of the head, etc. If each of these beliefs or practices be considered alone there are many breaks in the chain; but taken together the gaps may be filled in.

Such in outline is the theory, and in the space at our disposal it would be quite impossible to do adequate justice to any one of its many facets. We may perhaps mention two small points. Should we be on quite sure ground in assuming close maritime intercourse between the Persian Gulf and India from the eighth century B.C.? The evidence is surely in favour of a later date by some two or three centuries. And should we be justified in regarding the custom of burning incense before the corpse, when no attempt was made to preserve the body, as an indication of the influence of the Egyptian custom of mummification. Apart from such an influence, is incense-burning so inexplicable? We may be quite sure, with Prof. Elliot Smith, that it was never used for "disguising the odours of putrefaction." But his view surely assumes that its funerary use in Egypt, to restore magically its natural odours to the desiccated body, was its only possible use. Whereas in Babylonia, to mention but one country of the East, the ritual use of incense has descended from immemorial antiquity, and was doubtless present in funerary rites with quite other associations. L. W. K.

INDUSTRIAL SCIENTIFIC RESEARCH.

UNDER the above heading the *Quarterly Review* for October contains a timely and interesting paper by Mr. T. L. Humberstone, which reviews comprehensively the problem how best to apply the results of physical science, as studied in the universities and colleges, to the requirements of the industrial world.

At the outbreak of war the fact that this country was almost dependent on Germany for dyes seemed to come with the force of a rough awakening to the majority of British manufacturers, who during the last forty years had been deaf to the warnings which had been shouted at them repeatedly by the scientific chemists. The lesson of the dyes is being taken to heart to some extent by other manufacturers, and the urgent questions which have now to be answered have aroused much discussion. The Government of this country has also, at last, consented to acknowledge the importance of science in a national sense by appointing a committee of the Privy Council, assisted by an advisory committee of eminent scientific men. The functions of these bodies is to discover in what way scientific education can be modified, and the results of research made more widely applicable, so that both may be utilised to the advantage of industry and trade.

The discussions which have already taken place show how much opinions may differ about the working of such a scheme, but one or two things seem clear. As Mr. Humberstone properly points out, our universities and colleges must in future train a much larger number of students with the direct object of fitting them for an industrial

career. On the other hand, employers must be prepared to resort more commonly to methods of research and to engage a larger number of well-educated scientific assistants, to whom they must be willing to offer prospects of a satisfactory career.

In dealing with this question the natural reluctance of many manufacturers to divulge indiscriminately any part of their processes which, rightly or wrongly, they suppose to have a special value, must be recognised. Hence the difficulty of getting them to resort to a university or other laboratory of research outside the works.

Space does not permit us to discuss these points, but there appear to be only two ways out of the difficulty. If the services of highly-trained scientific men are to be utilised more than has been the case hitherto, as must be done if we are not to be out of the running altogether, our manufacturers must not expect to get manufacturing experts direct from the universities, for it is certain that industrial applications of science can only be properly learnt in the works. The plan long ago adopted in Germany, and to some extent in America, consists in engaging thoroughly well-informed young men, usually graduates, for a period of years, at a salary on which they can at least live, while they are learning in practice to apply their knowledge to the business. Future advancement, of course, depends on the aptitude and diligence shown in the first year or two.

The other plan is represented by the scheme of industrial fellowships inaugurated by the late Prof. Kennedy Duncan in connection with the Universities of Kansas and Pittsburgh, as explained in NATURE of October 21 (p. 203). The essence of the idea is that in such an institution as the Mellon Institute at Pittsburgh arrangements of a confidential character can be made whereby the services of one of the fellows working at the institute can be secured, on mutually agreed terms, by any manufacturer who has problems which he desires to investigate with due privacy. All we can do is to await with interest the results of experience gained at Pittsburgh, or try the plan on a smaller scale at one of our own universities. In any case it is certainly imperative that co-operative relations be forthwith established between our universities and the industries which are dependent on science.

THE SUPPLY OF NITRATES.

ONE of the minor misfortunes to the cause of the Allies, coming through no fault of their own, has been the landslide in the Panama Canal, which has interfered with the import of nitrate of soda from Chile by prolonging the time of the voyage. Nitrates are, of course, required in enormous quantities for explosives, but a very considerable amount of nitrate of soda—no less than 100,000 tons per annum—is used in agriculture for manurial purposes. No modern farmer would like to try to do without it; indeed, any increase in food production almost necessarily means an increase in nitrate consumption. Yet Mr. Acland recently stated in the House of Commons that the quantity now in this country, or on the way to it, was only about 30,000 tons.

As yet the situation is not serious. Farmers do not use nitrate of soda until spring-time; February or March would represent the earliest date when most people would apply it to their crops. Further, the Board of Agriculture has already made an arrangement whereby farmers can buy the sulphate of ammonia produced in this country, and formerly exported, at a price not much above the pre-war prices—14*l.* 10*s.* per ton instead of 12*l.* 10*s.* To this extent the situation is relieved, but, nevertheless, no one would care to see the supply of nitrate too much restricted.

There are two ways of dealing with the difficulty. One is to leave it alone, and trust that matters will somehow right themselves before February; the other is to arrange forthwith for a supply of artificial calcium nitrate. This substance was on the market as a fertiliser before the war; it has been tested on the large scale, and is known to give satisfactory field results; its defects have been studied, and a body of experience has been gained which would now prove very useful. But somehow it seems to have disappeared as a fertiliser since the war began. It ought not to prove impossible of manufacture, and in any case the situation ought not to be allowed to develop too seriously before steps are taken to cope with it.

PROF. THEODOR BOVERI.

DR. THEODOR BOVERI, whose death on October 15 was announced in NATURE of November 11, was born on October 12, 1862, and was the successor of Carl Semper in the chair of zoology and comparative anatomy in the University of Würzburg. He received his university education in Munich, where he had the good fortune to be one of Richard Hertwig's first pupils. There he studied natural science and medicine, graduating in both and becoming *privat-docent* in 1887. In 1893 he was called to Würzburg, where, in spite of offers of other appointments, he remained for twenty-two years. In 1913 he declined the post of director of the Kaiser Wilhelm Research Institute in Berlin. Extensions of his overcrowded research laboratories were granted, and he was made "Geheim Rat." In 1905–06 he was rector of the University. He held the membership of many scientific academies. But probably honours and titles had little meaning for Boveri, for, like Semper, he was a very modest man.

Among modern zoologists Boveri occupied a somewhat unique position. Properly speaking, only one of his memoirs, his masterly study of the excretory organs of Amphioxus—which he and Weiss discovered independently—can be described as purely zoological. His other work—and its total is by no means small or unimportant—related mainly to cytology. For research in this field Boveri had a positive genius. To him we owe the first proof, in Ascaris, of the true nature of the

polar bodies of oögenesis as rudimentary gametes. He set up the numerical law of the chromosomes, and adduced cogent evidences in favour of the persistence of their individuality from cell-generation to cell-generation. He discovered the curious "casting-out of chromatin" in Ascaris, and some of his beautiful experiments relate to the history of an organism destitute of maternal attributes, due to the fertilisation of an egg-fragment by one or two sperms. His cytological memoirs, among the classics of the science, are contained mainly in the six published parts of the "Zellenstudien" (1887–1907), in Richard Hertwig's "Festschrift" (1910), and in the magnificent monograph on the development of Ascaris, which he contributed, as one of his pupils, to the "Festschrift für Kupffer" (1899).

ADOLPHE GREINER.

ADOLPHE GREINER, director-general of the John Cockerill Co., Seraing—the foremost steelworks in Belgium and one founded by an Englishman of that name many years ago—and president of the Iron and Steel Institute, died at his residence near Liège on November 20.

Mr. Greiner was born in Brussels in 1843 and was the eldest son of Gustave Greiner, private secretary to King Leopold, the first King of the Belgians. Educated at the University of Liège he obtained the diploma of the School of Mines in 1864, and shortly afterwards was elected to the post of engineer chemist to the Société Anonyme John Cockerill, which was the first steel manufacturing company on the Continent to adopt the Bessemer process. Five years later he was appointed manager of the steel works, and in 1887 he became director-general, a position he continued to fill until his death. He was responsible for the introduction there of the basic process for steel making, and was one of the earliest promoters of the use of blast furnace and coke oven gas for the direct driving of internal combustion engines.

Not only was he one of the most distinguished figures in the industrial life of Belgium, but he played an important part in the development of the iron and steel industries of other countries. Numerous honours were conferred on him during his long career by the sovereigns of his own and other countries. He had been president of all the leading scientific Belgian societies, and as president of the central committee of industrial labour he had rendered important services to the social welfare of Belgium. He joined the Iron and Steel Institute in 1876, was a frequent attendant at its meetings, served for many years on the council, and was elected president in May, 1914. The year previous he had been awarded the Bessemer Gold Medal.

During the siege of Liège in August, 1914, Mr. Greiner remained at his post continually, encouraging with his unfailing spirit the members of his staff and his workmen, and organised means for the alleviation of distress among the large population dependent on his company for employment. In the following months he set on foot experiments in the heating of open-hearth furnaces by means of tar in order to overcome the difficulty of the shortage of gas coal. His results were presented to the Iron and Steel Institute in a short paper in May of this year, and this last contribution will remain as a record of his courage and resource in the midst of many difficulties and adversities. He was a man of large mind and wide sympathies, and towards the members of his staff and the thousands of operatives employed at the works he occupied a kind of patriarchal position, and was ever ready to help any of them from the highest to the lowest with his advice or benevolent assistance.

ANNIVERSARY MEETING OF THE ROYAL SOCIETY.

THE anniversary meeting of the Royal Society was held on Tuesday, November 30, when the report of the council was presented and Sir William Crookes delivered his presidential address, extracts from which are subjoined. In the report of the council particulars are given of the various committees of the society concerned with scientific problems connected with the war. We hope to publish the main part of this account in another issue, together with a description of the work of other committees with like objects. Meanwhile, we give Sir William Crookes's outline of the Royal Society's activities in this direction.

Towards the end of last year a war committee and sub-committees were appointed to consider a variety of questions, including the supply of drugs and other chemicals which hitherto have been mostly imported. It was finally decided that it would be best for the council as a whole to act as a general war committee, the original sub-committees being converted into four sectional committees, which have met regularly throughout the year. A memorial to the Prime Minister was drawn up, directing attention to the urgent need for closer co-operation between those engaged in scientific research and the directors of the nation's industries, and was presented by delegates of the Royal Society and the Chemical Society. The President of the Board of Education has since issued a scheme for the organisation and development of scientific and industrial research, which has met with approval on all sides, and indicates that the Government is ready to give the country a strong lead in the way of recognition of the value of scientific training and work. An important step has been taken in appointing a committee to prepare a scheme for the establishment of a permanent board in collaboration with technical and other scientific societies for the discussion of questions in which joint action appears desirable.

Owing to unavoidable delay in printing, the Royal Society's Catalogue of Scientific Papers has progressed only slowly, and there appears to be no likelihood of its being completed at the present rate until the middle of 1921. The director of the catalogue, Dr. McLeod, who has been indefatigable in his labours, has been obliged by ill-health to retire. It is proposed not to appoint a new director, but to continue the work under the able management of the chairman of the Catalogue Committee, Prof. Silvanus Thompson.

Another of the society's tasks, the magnetic re-survey of the British Isles, has been continued at a reduced rate, and with some interruptions throughout the year just passed. At present only the Hebrides, Isle of Man, Channel Isles, and six points in England and Wales remain unresurveyed.

The Copley medal has been conferred upon PROF. IVAN PETROVITCH PAVLOV, one of our most distinguished foreign members, whose researches in physiology have led to the acquisition of valuable knowledge. By a most ingeniously worked-out and original method of making fistulæ or openings to the exterior, Prof. Pavlov has successfully studied the interrelation of the functions of the alimentary canal. His experiments have shown how the presence of food in one cavity controls the secretion of digestive juices into the next, and he has made many discoveries concerning the conditions which influence the secretory process, while his method has facilitated the study of the chemical changes which occur in the food as it passes through the canal. Moreover, by the method which he calls that of conditioned reflexes, Prof. Pavlov has studied, from a physiological point of view, the influence of the higher brain centres upon the secretion of saliva. He has also investigated the mechanism of the muscle by which bivalves open and close their shells, and the nervous control of the heart, especially through the sympathetic nerves. His resourcefulness and skill have enabled him to make important contributions to physiological science, and his work, the true worth of which has, perhaps, not yet been rightly prized, deserves the fullest recognition.

The Royal medal given annually for physical investigations has been awarded to SIR JOSEPH LARMOR, whose work in mathematics and physics includes a very wide range of subjects—geometry, dynamics, optics, electricity, the kinetic theory of gases, the theory of radiation, and dynamical astronomy—upon all of which he has published illuminating memoirs. Possibly his chief claim to distinction is the establishment of the theory that radiant energy and intra-molecular forces are due to the movements of minute electric charges. This theory is fully worked out in his treatise, "Æther and Matter." For a long time Sir Joseph Larmor acted as secretary to the Royal Society, performing the duties of the office with great success, at the same time continuing with unabated vigour original research. The offer of the Royal medal is a mark of the society's appreciation and admiration of his invaluable services to science.

The other Royal medal, for work in the biological sciences, is this year conferred upon DR. WILLIAM HALSE RIVERS RIVERS, whose work in ethnology has contributed largely to the establishment of the subject upon a scientific basis. He was the first to use the genealogical method in ethnological investigations. His remarkable originality, combined with sound judgment, have enabled him to produce work which will rank with the best that has been done in ethnology.

All chemists will agree that the award of the Davy medal to PROF. PAUL SABATIER is fully justified. His lengthy researches on the use of finely divided metals as catalysts are universally known. The hydrogenation of unsaturated organic compounds, especially by means of nickel, has been thoroughly elucidated by Prof. Sabatier and his co-worker, the Abbé Senderens, The industrial application of the process to the unsaturated acids of the oleic series has already acquired considerable industrial importance. It gives me great pleasure to announce the award, so well earned by Prof. Sabatier.

The Hughes medal is awarded to PROF. PAUL LANGEVIN, who has made valuable contributions to electrical science, both on the theoretical and experimental sides. He has found by experiment the rate of re-combination and the mobility of ions produced by different processes in gases at various pressures, and he has made an exhaustive study of the theoretical aspects of the interdiffusion of gases and the mobility of ions.

The nation's attitude towards science is, I think, largely due to the popular idea that science is a kind of hobby followed by a certain class of people, instead of the materialisation of the desire experienced in various degrees by every thinking person to learn something about innumerable natural phenomena still unsolved; and, having learned, to control and apply them intelligently for the benefit of the human race. Many attempts have been made to explain exactly what is meant by science, and to differentiate true science from its counterfeit; and it is by no means easy to define it so that the vague general idea of the average man can be replaced by clear and precise conception. Even the most patient investigator, the most acute observer, must constantly feel, "Oh, what a dusty answer gets the soul when hot for certainties in this our life." If we refer to our charter, we shall find that the aim of the Royal Society is promoting natural knowledge by experiments, and if we regard science as synonymous with natural philosophy we may describe it as knowledge relating to natural objects and phenomena connected therewith based upon experiments. Life has been defined as the act of correspondence with our environment, and science may equally tersely be defined as the use of intelligence in effecting that correspondence.

I believe that the "Hobby" attitude is due to our national character, and can only be rectified slowly, step by step. We cannot suddenly become a truly scientific nation, either now during the war, or immediately on its conclusion. We shall have to make many fundamental alterations in our ideas and almost to change our natures before such a change can be effected. First among our defects must surely be placed mental inertia, our reluctance to do our thinking for ourselves, and the slowness of our intellectual apprehension. This condition is fundamentally different from docility of mind, and its results are more disastrous because it tends to inhibit action on the part of those who should be leaders. Associated with it, of course, is our inherent stolid conservatism, which makes us too readily satisfied to continue in the ways of our forefathers—ways which, though good enough once upon a time, are now obsolete and undesirable. We are sometimes prone to under-estimate our opponents' abilities and powers, and usually we have a hearty contempt for outside criticisms of our methods. Our mental inertia makes us slow to put our latent organising power into action.

The problem before us is twofold. We have, first, to find out how best to organise all our present forces and employ the material at our disposal to win victory. Many suggestions have recently been made as to the best way to mobilise science and invention, so that, for example, schemes that show some likelihood of having military or naval value can be put at once to the test. At the beginning of the war the Royal Society appointed committees for this purpose. Their scope could be extended usefully. They include men of naval and military experience, whose practical skill and knowledge supplement the theories of men of science.

The second part of the problem is closely interwoven with the first, and its importance to the nation is hardly inferior. If we neglect to alter our ways, if we continue to disregard the value of scientific work and are content with ignorance of scientific methods on

the part of the authorities, we shall assuredly suffer total defeat in the industrial war which must of necessity follow upon the conflict of arms now raging. This is a matter in which men of science have a great responsibility to the nation. We must not cease to bring to the notice of the public the facts of which we are too fully aware. The attitude of the Government and the public towards science has been mistaken. For this formidable error we suffer and, I fear, must long continue to suffer. The remedy involves many sacrifices and heavy expenditure, probably at first without apparent return. It is to the new generation now being educated that we must look for betterment of our position; and it is for youth we must now make plans. We must make all education more scientific. It is admitted we have much to learn from our adversaries; we must bring scientific methods to the front.

Should not science be represented on the Privy Council? It is astonishing that in so august a body science is almost ignored. Ought we not to have in the Cabinet a Minister of Science with a board of advisers similar to that of Agriculture, with the proviso that the Minister of Science should hold his office primarily by virtue of his scientific capacity? Power of organisation and general business ability should be regarded as essential secondary qualifications. The newly appointed Science Councils and Committees might be incorporated under the Ministry of Science —then and then only pure research would begin to take its place as an invaluable profession, with a status of its own at least on a level with that of other learned professions. The leaders of its rank and file would be doing work of fully as much value to the nation as the work of the officers of our naval and military forces. Then, I feel convinced, the next generation would see the disappearance of listless cooperation between manufacturer and scientific workmen, and we should hear less of the inferiority of British science as compared with that of our opponents. Given equal opportunities, our men would speedily give proof of fertility of ideas, of organising powers, and of resource and initiative. Research could be so thoroughly well organised that suitable workers would be jointly engaged with those problems for the speedy elucidation of which there is the greatest need, and the results of their investigations would be at the disposal of all British manufacturers. It rests with us to keep these ideas before the mind of the public now that at last it is ripe to consider them. "Be wise to-day; 'tis madness to defer."

In conclusion, Sir William Crookes referred in felicitous words to the election of Sir J. J. Thomson as his successor in the presidential chair of the society.

NOTES.

THE Amsterdam correspondent of the *Morning Post* announces that the Dutch Royal Academy of Sciences has awarded the gold Leeuwenhoek medal for 1915 to Surgeon-General Sir David Bruce.

THE Croonian Lecture of the Royal Society will be delivered on Thursday, December o. by Dr. W. M. Fletcher and Prof. F. G. Hopkins, on "The Respiratory Process in Muscle, and the Nature of Muscular Motion."

THE death is announced, at his residence in Dublin, of Dr. Francis T. Heuston, formerly professor of anatomy in the Royal College of Surgeons, Ireland, and lecturer on anatomy in Carmichael College, Dublin. Dr. Heuston was well known as a consulting surgeon, and contributed many papers on professional subjects to the medical journals.

AT the annual meeting of the Iron and Steel Institute, to be held next May, Sir William Beardmore, Bart., will be inducted into the chair as the new president of the institute, in succession to Dr. Adolphe Greiner. The Bessemer gold medal for 1916 will be presented to Mr. F. W. Harbord, honorary consulting metallurgist to the Ministry of Munitions. It has been decided not to hold an annual dinner next year.

AT the meeting of the Faraday Society on Wednesday, December 8, a general discussion on "The Corrosion of Metals—Ferrous and Non-ferrous," will take place. The president, Sir Robert Hadfield, will take the chair. The members of the Iron and Steel Institute and of the Institute of Metals have been invited to attend the meeting. Other persons desirous of attending can obtain tickets on application to the secretary of the Faraday Society, 82 Victoria Street, S.W.

IT is announced officially that arrangements have been made between the Army Council and the Ministry of Munitions for the transfer to the latter of responsibility for designs, patterns, and specifications, for the testing of arms and ammunition, and for the examination of inventions bearing on such munitions. Instructions have therefore been given for the immediate transfer to the Ministry of Munitions of the Ordnance Board, Research Department at Woolwich, Experimental Establishment at Shoeburyness, and the War Office Inventions Department.

THE death is reported, at the age of seventy-two, of Dr. E. L. Greene, the head of the botanical department at Notre Dame University, Indiana. He was professor of botany at the University of California from 1885 to 1895, and at the Catholic University of America from 1895 to 1904. He had also had an official connection with the Smithsonian Institution. Dr. Greene, who was the author of several monographs and of a flora of the San Francisco district, was president of the International Congress of Botanists held in connection with the Chicago Exposition of 1893.

AT the November meeting of the Royal Physical Society of Edinburgh, the following office-bearers were elected for the 145th session, 1915–16:—*President:* Prof. Arthur Robinson; *Vice-presidents:* P. H. Grimshaw, Prof. D'Arcy W. Thompson, Dr. J. H. Ashworth; *Secretary:* Dr. James Ritchie, Royal Scottish Museum; *Assistant Secretary:* J. A. S. Watson; *Treasurer:* Wm. Williamson; *Librarian:* L. W. Hinxman; *Councillors:* Hugh Miller, Dr. Malcolm Laurie, J. Kirke Nash, Dr. B. N. Peach, Dr. J. F. Gemmill, Dr. John Rennie, Dr. D. C. McIntosh, Principal O. C. Bradley, Wm. Evans, Prof. T. Hudson Beare, T. H. Gillespie, and Prof. D. C. Matheson. In the Report of Council it was stated that two fellows of the society, Mr. L. N. G. Ramsay and Mr. C. H. Martin, had been killed in battle in France.

At the request of General Sir O'Moore Creagh, military adviser to the Central Association Volunteer Training Corps, an Engineer Volunteer Corps has been formed to meet the needs of members of the engineering profession who, by reason of age, physique, or employment on Government work, are prevented from joining the Regular or Territorial Forces. The official regulations of the association say that the policy of the Government is to encourage every man to take his part in the present struggle; and they advise all who are debarred by the reasons mentioned above to join a Volunteer Corps, so that their services may be available as a trained man in case of invasion. All men with engineering experience should join an engineer corps, where they can be trained in military engineering, especially field and fortress work (including telegraphs, searchlights, etc., in addition to infantry drill, musketry, etc.). Such a training, combined with the experience which they have gained in civil life, will render them invaluable to the authorities at a time of emergency. The Engineering Institutions Volunteer Engineer Corps gives such a training; and although the corps has not been in existence six months, a number of men are already proficient in searchlight work, and available in case of need. Sir John Snell is hon. commandant of the corps, and the general committee contains many prominent members of the engineering profession. The headquarters of the corps are at Chester House, Eccleston Place, S.W., but full information may be obtained from Lieut.-Colonel C. B. Clay, Marconi House, Strand, W.C.

The death of Sir Allen Young, C.B., announced in the *Times* of November 20, removes one of the last survivors of the Franklin search expeditions. In his early days Allen Young entered the mercantile marine and commanded a troopship in the Crimean War. When Lady Franklin in 1857 organised an expedition to follow up Dr. John Rae's discoveries concerning the fate of her husband and his expedition, Allen Young was appointed master of the *Fox*, under Captain (afterwards Sir Leopold) McClintock. Young contributed largely to the finances of the expedition, and refused any remuneration for his services. On this expedition Young accomplished important work. In a long sledge journey he completed the discovery of Prince of Wales Island, and the west coast of North Somerset. He found McClintock Channel blocked with heavy ice and unnavigable, and pointed to Franklin Channel as the route of the north-west passage. Amundsen has since proved the truth of this contention. In 1875, in his steam yacht *Pandora*, Young led an expedition to Lancaster Sound and Bellot Strait, and in 1876 to Smith Sound. In 1882 he led the Leigh Smith search expedition in the *Hope*. Among other services, Young took part, in 1860, in the survey of the proposed North Atlantic telegraph route from the Faroes by Iceland and Greenland to Labrador. Sir Allen Young, who was knighted in 1877, was born at Twickenham eighty-five years ago. He was a younger brother of Trinity House, and a former member of the council of the Royal Geographical Society.

By the death of Dr. James Holms Pollok on Friday last, November 26, Ireland has lost a very earnest and able scientific worker. Dr. Pollok was for many years on the staff of the Royal College of Science for Ireland, in the chemical department of which he was lecturer on physical and metallurgical chemistry. He had achieved a well-earned reputation as an industrial chemist, and was ever alert for new openings in the applications of chemistry which might benefit this country. Workers in science will remember that he was honourably associated with the late Sir Walter Hartley in researches in spectroscopic analysis—work that he continued after the death of that investigator. As a result of working with vacuum tubes, he suffered for some months from a very painful form of eczema (ultra-violet light dermatitis), induced by the rays emitted from these tubes. On the outbreak of war he devoted himself to the services of the common cause, and in time organised the Royal College of Science Voluntary Aid Detachment, and with this detachment, of which he was quartermaster, he performed very valuable services on the several occasions on which wounded soldiers have been landed in Dublin. Dr. Pollok's published contributions to chemistry and spectroscopy are represented by twelve papers communicated to the Chemical Society and the Royal Dublin Society. The chemical papers deal with a study of glucinum and its compounds, the analysis of Irish kieselguhr and the separation of rare earths. His spectroscopic researches were devoted to an examination of the spark and vacuum tube spectra of the rare and common metals, and to the utilisation of these spectra in quantitative analysis. His loss will be deeply felt by the Department of Agriculture and Technical Instruction and by the Royal College of Science for Ireland, where he was held in great esteem and affection by his colleagues and students. He leaves a widow and two daughters to mourn his loss.

At the monthly general meeting of the Zoological Society of London, held on November 17, the report of the council for the months of August, September, and October was read. Herein it was stated that during these months 406 additions had been made to the society's menagerie. Some of these were of exceptional interest. Special mention may be made to the entries for September, which included a tiger-bittern (*Tigrosoma salmoni*), ten Wilson's birds of paradise (*Schlegelia wilsoni*), ten red birds of paradise (*Paradisea rubra*), and one black manucode (*Manucodia atra*). The attendance at the gardens during the months covering this report was most gratifying, since no fewer than 436,733 passed the turnstiles, being an increase of 128,907 over the corresponding period of last year.

An address by Mr. C. P. Lounsbury, on "Some Phases of the Locust Problem," delivered before the South African Association for the Advancement of Science, is published in the *South African Journal of Science* for September. From this it is apparent that "the Union is entering upon a cycle of years when swarms of locusts will be widespread and destructive." The invading hosts have in the past been made up of two distinct species—the brown locust (*Locusta*

pardalina) and the red locust (*Pachytylus capensis*). The author briefly and lucidly reviews the previous records of such visitations, from 1653 to the present day. From the data thus collected he is enabled to show that these outbreaks follow close on the heels of seasons of prolonged drought, and is further always associated with large tracts of naturally arid country, where the rainfall is both scanty and erratic. He gives valuable notes on the life-histories of these insects, and on their natural enemies. In regard to the brown locust, he is of opinion that the eggs preserve their vitality for years in the absence of adequate moisture for their development. If indeed this be the case, it is certainly very remarkable.

THE ravages of locusts forms the subject of a special bulletin issued by the United States Department of Agriculture (No. 293). This deals with the "Grasshopper Outbreak in New Mexico during the Summer of 1913." The species mainly concerned is the long-winged grasshopper (*Dissostera longipennis*). The author, Mr. Harrison E. Smith, traces the history of this insect in America, and then proceeds to describe the life-history in detail. Among its numerous enemies birds, lizards, and toads are the most effective in keeping down its numbers. No less important are a parasitic fly (*Sarcophaga kellyi*), and sphecid and bembecid wasps. The former deposit living larvæ upon the adults, which are then doomed to be devoured alive, while the wasps paralyse large numbers and store them to serve as food for their young. But in spite of the ravages of their enemies it seems necessary to resort to artificial remedies to exterminate these pests. Of these the most effective is that afforded by a mixture of Paris green, bran, and molasses, to which is added the skin and pulp of oranges or lemons. The effect of the wholesale distribution of poison on other animals is not stated.

Two species of the genus Rhizoctonia of some economic importance in India form the subject of a paper by Messrs. Shaw and Ajrekar in Memoirs of the Department of Agriculture in India, vol. vii., No. 4. These are *R. napi*, West, which was found as a virulent disease on mustard and on grasses, and *R. destruens*, Tass., on potatoes. Betel vine (*Piper betle*) is also seriously affected by this latter fungus in Bengal and Bombay. *R. napi* is an omnivorous parasite, and was found to attack all plants in the vicinity of the mustard plot where it first appeared. Methods of soil sterilisation and for disinfecting potato tubers are given. It seems possible that under the name Rhizoctonia we are dealing with an artificial group of which the different species are vegetative stages of widely separate fungi with morphological similarities, and a study of *R. napi* strengthens this suggestion, since it appears that it is merely a sclerotial stage of a Botrytis. The paper is illustrated by six plates.

THE genus Antennaria is represented in Greenland by several well-marked species, though usually considered to be merely forms of *A. alpina*, a species closely allied to the well-known *A. dioica* of Europe. M. P. Porsild, in *Meddelelser om Gronland*, li., describes and figures four species, of which he has made a close study at the Danish Arctic Station at Disko, Greenland. *A. alpina* is a widely distributed Arctic alpine form extending into North America. *A. glabrata* appears to be confined to Greenland. *A. groenlandica* is a rare plant met with in southern Greenland, and probably American in origin, and *A. intermedia*, also a rare species, is found chiefly near Disko, where it may form large colonies. It is of interest to notice that *A. alpina* has been found at an altitude of 4100 ft. on Jensen's Nunatakker, in southern Greenland. All the species set seed freely, but they are apparently apogamous, as there is no record of any male plants having been seen in Greenland.

THE jand forests of the Punjab are spread over the arid, alluvial plains, where, as a rule, the rainfall does not exceed 10 in. The area covered is some 3500 square miles, and the three dominant trees are jand (*Prosopis spicigera*), wan (*Salvodora oleoides*), and karil (*Capparis aphylla*). Of these jand is a fairly valuable tree of local importance. It is chiefly remarkable owing to the length of its tap-root, specimens having been found with a tap-root as much as 84 ft. in length descending vertically to a depth of 64 ft. Mr. B. O. Coventry, in his paper on these forests in the *Indian Forester*, vol. xli., No. 9, 1915, points out that this tap-root enables the tree to obtain its water from the permanent water supply in the subsoil. Doubtless at one time the jand lived in a region liable to floods, since it has been found that no natural regeneration occurs in the jand forests, though in irrigated or flooded districts the jand is reproduced readily from seed. It seems probable that the explanation of the long tap-roots is due to the effort on the part of the tree to keep pace with the gradual lowering of the water table in the soil, resulting from the lowering of the river-beds by erosion.

OWING to the large number of papers of fundamental significance to agriculture that are awaiting publication in the *Journal of Agricultural Research*, the Secretary of the Department, Washington, announces that, beginning with vol. v., a number of the journal will appear each week. Since Russell and Hutchinson put forward their theory of the influence of protozoa upon soil fertility, much work has been done in America in the field opened out by their researches. In No. 3 of the new volume, Kopeloff, Lint, and Coleman describe a method for quantitatively separating protozoa into classes as flagellates, small ciliates, and large ciliates. The culture solution under examination is filtered through from one to five thicknesses of sterile filter-paper. The protozoan content in the filtrates passing through in the first minute is then recorded in triplicate by the authors' method described in a previous paper. The filtrates are further incubated to allow the development of any encysted forms. By treating soil and hay infusions in this way, it was found that the large ciliates are unable to pass through filter-paper at all, as noted by Russell and Hutchinson, while three thicknesses of the paper were required to remove all the small ciliates. No protozoa were found in the filtrate from five papers. In this way, mass cultures

of flagellates and small or large ciliates may be employed as necessary in attacking the difficult problems in soil protozoology that await solution. An attempt to prepare, by similar means, cultures of protozoa free from bacteria was unsuccessful, as only 90 per cent. of the bacteria could be removed. It appears unlikely that a complete separation could be effected by this method.

WE are indebted to Mr. Otto Klotz, of the seismological observatory of Ottawa, for a copy of the seismogram of the remarkable earthquake of September 6–7. The record was obtained by means of a Bosch photoseismograph. Mr. Klotz estimates that the epicentre was 3750 kilometres from Ottawa, in lat. 14° 14′ N., long. 90° 30′ W., that is, beneath the Pacific, a short distance from the coast of Guatemala.

SURVEY work in New Zealand was seriously curtailed last year owing to decrease in staff due to many enlistments. The triangulation made slow progress, and other survey operations suffered, though in a less degree. The report on the survey operations for the year 1914–15 (Wellington, 1915) mentions the completion of maps of New Zealand on scales of an inch to ten miles, and one to a million, and annouces their publication at an early date.

IN an article on the underground waters of Australia in the *Scientific Australian* (vol. xxi., No. 1, September, 1915) Mr. T. Parker directs attention to the diminished flow of water in many of the artesian wells of New South Wales, Queensland, and South Australia. An interstate conference which considered the matter heard a good deal of conflicting evidence, but came to the conclusion that the decrease was mainly due to a reduction in the supply of underground water. The opinion is held, however, that it may be due to corrosion causing defective casings in the wells, and by shocks causing breakages and leakage. Mr. Parker advocates a new investigation and a systematic survey of the wells. He hints that several of the States will shortly undertake this.

RECENT political events lend exceptional interest to the three illustrated articles which form the contents of the *National Geographic Magazine* for October (Washington, D.C.: National Geographic Society). Mr. George Higgins Moses, formerly United States Minister to Greece, contributes an article on "Greece of To-day," containing photographs both of Greek people and of historic remains. Under the authorship of "Hester Donaldson Jenkins," we have an article on Armenia and the Armenians. The illustrations in this case mainly depict the features of different types of the Armenian race; in addition, there is a beautiful frontispiece of Mount Ararat, evidently printed by an efficient differential method. The writer of this article contributed a previous article to the same magazine in April last under the title "Bulgaria and its Women." Lastly, we have Mr. James Howard Gore's article on "Roumania the Pivotal State," describing the effects on that nation of Roman envy, Goth and Hun invaders, and showing pictures of its modern towns. In the concluding sentences the author says:—"Just now a greater conflict is raging, and the aid of Roumania is eagerly sought. Is she a pivotal State? If so, which way will she turn and what will be her reward?"

WE have received from the Carnegie Institution of Washington a classified list of its publications. The list is worth examination as an example of careful bibliography. It begins with a numbered list of the publications, giving the bibliographic details. This is followed by a catalogue of the same works classified according to subject-matter. Short accounts giving a clear idea of the argument of each of the publications form a special feature. These *résumés* appear to have been written by the authors of the books catalogued, and are in many cases in themselves quite interesting. The title often gives a very inadequate idea of the contents of a book or paper, and it is therefore much to be desired that authors should make a practice of giving a short argument or abstract as a preface to their longer papers. An alphabetical list of authors' names, including the names of collaborators, forms a useful appendix. In addition to the well-known "Index Medicus," which has now reached its fourteenth annual issue, there are in the catalogue more than 200 books and pamphlets dealing for the most part with scientific questions. These have all been published during the last ten years. Most of the physical and biological sciences are represented. Included in the list are collections of zoological papers from the Tortugas Laboratory of the Carnegie Institution and from the department of marine biology of the institution. The admirable way in which the list has been drawn up makes it possible to realise how much the Carnegie Institution has done, and is doing, for science.

THE September number of *Terrestrial Magnetism and Atmospheric Electricity* contains the first part of an article by Dr. W. F. G. Swann on the origin and maintenance of the earth's electric charge. After a short account of the leading facts of atmospheric electricity—the increase of electrical potential with altitude, the negative charge on the earth's surface, the positive charge of the atmosphere—Dr. Swann shows how difficult it is to account for the maintenance of these conditions, and how inadequate are the theories which have been put forward to explain them. Electrodynamical theories give forces too small; the emission of electric charges by the sun fails to account for the phenomena at night; the rain precipitation theory is not supported by measurements; the mobility theory has been shown to postulate a property of the negative ions they do not possess; and the theory that ionised air from cavities in the earth's crust is responsible for the principal phenomena fails to account for the observations made over the ocean. It is to be hoped that the second part of Dr. Swann's article will provide some more satisfactory explanation of these puzzling phenomena.

TECHNOLOGICAL PAPER No. 53 of the United States Bureau of Standards contains an account of an investigation of fusible tin boiler plugs. Such plugs are fitted to the top of the boiler furnace and are normally surrounded by water. Should the water level in the

boiler fall to a dangerous extent, the plug becomes hot, melts, and blows out, thus extinguishing the fire before overheating of the furnace plates can take place. It is well known that the behaviour of fusible plugs is somewhat erratic, and that they may be a source of danger on account of the false sense of security which they induce. It appears that there are two types of failures, those in which an oxide is formed as an interlocking network throughout the tin of the filling, and those in which the oxide forms as a solid hard mass at the fire end of the plug. In more than 1000 plugs examined, lead and zinc were found to be the principal impurities present, and an explanation of the formation of the network type of oxidation is found in the presence of zinc in amounts varying from 0·3 to 4 per cent. The use of pure tin of the quality of Banka (lead, traces up to 0·01 per cent.; zinc, traces) or of Straits (lead, up to 0·08 per cent.; zinc, traces up to 0·015 per cent.) would probably eliminate the danger of oxidation of these plugs in service.

A PAPER on the chemical and mechanical relations of iron, molybdenum, and carbon was read at the Institution of Mechanical Engineers on November 19 by Profs. J. O. Arnold and A. A. Read. Practical metallurgists estimate from lathe and drill experiences that, roughly, the steel-hardening power of molybdenum is from two to three times as great as that of tungsten. Theoretically, one atom of carbon is about 2·28 times as powerful in producing hardenite in true ferro-molybdenum steel as it is in forming the hardenite of true tungsten steel. Unfortunately, molybdenum is much more erratic in its behaviour than tungsten, and the latter, though the less powerful element, still sits unshaken on its throne, because of its trustworthy behaviour. The authors direct attention to the exceedingly poor mechanical properties of molybdenum steels compared with the corresponding steels containing tungsten. High molybdenum steel quenched out at a proper hardening temperature is very brittle, and it is clear that so powerful a steel-producing element should be used sparingly, avoiding large percentages. With low percentages it exerts a beneficial influence on certain classes of steel, when used cautiously either *per se*, or to replace about 2·5 times its percentage of tungsten.

THE annual report of the Board of Regents of the Smithsonian Institution for the year ending June 30, 1914, has been received from Washington. The first part of the volume, which runs to 729 pages, is devoted to the report of the secretary, which contains a summary of the researches and explorations carried out under the auspices of the institution, and eight appendices dealing with the year's work of the United States National Museum, the Bureau of American Ethnology, the National Zoological Park, the Astrophysical Observatory, and other organisations subsidised by the institution. But the most attractive section of the volume is the general appendix of nearly 600 pages containing thirty-two articles on recent advances and developments in science. These contributions are selected from scientific publications all over the world, and many are not easily accessible. The following translations of foreign scientific papers deserve special mention:—Modern theories of the sun, M. Jean Bosler, astronomer at the Meudon Observatory; Some remarks on logarithms apropos to their tercentenary, Prof. L'Ocagne, professor at the Ecole Polytechnique, Paris; The geology of the bottom of the seas, Prof. L. de Launay, professor at the Ecole supérieure des Mines, Paris; Recent oceanographic researches, Dr. Ch. Gravier; Homœotic regeneration of the antennæ in a plasmid or walking-stick, Mr. H. O. Schmit-Jensen, of Copenhagen; Latent life: its nature and its relations to certain theories of contemporary biology, Dr. Paul Becquerel; Excavations at Abydos, M. Edouard Naville; The rôle of depopulation, deforestation, and malaria in the decadence of certain nations, Dr. Felix Regnault; and a sketch of the life of Eduard Suess, by M. Pierre Termier, of the Paris Academy of Sciences. As usual, the volume is profusely and beautifully illustrated.

OUR ASTRONOMICAL COLUMN.

COMET 1915*d* (MELLISH).—The Copenhagen telegram announcing the discovery of this comet gave its position on September 19. According to the *Astronomische Nachrichten* (No. 4820), it was first seen by Mr. Mellish on the night of September 13, whilst on September 18 it was independently found by van Biesbroeck, Yerkes Observatory.

OCCULTATIONS BY THE MOON.—On the evening of December 10 the distant planet Uranus will be occulted by the moon. The disappearance of Uranus will occur at 6.2 p.m., and the reappearance at 6.10 p.m., so that the object will be hidden for a short period only by the limb of the moon in the apparent S.E. region of her disc. She will be four days old at the time, and visible as a narrow crescent with the opaque part perceptibly involved in earthshine. At the time of occurrence of the phenomenon the objects will be situated in the S.W. sky at a low altitude. Our satellite sets at 8.28 p.m.

On the night of December 18 some of the stars forming the Pleiades group will suffer occultation between 11h. 55m. and 13h. 51m. astronomical time. The occultation of these stars, and also that of Uranus on December 10, will require a fairly good telescope to be witnessed effectively, as the stars and planet are small, and will be partially overcome by the moon's light. This, however, refers more particularly to the occultation of the Pleiades, which takes place at a time when the moon is nearly full.

THE PERSEID METEORS IN 1915.—Meteoric astronomy is not only considerably alive in this country, but is also attracting increasing attention in the U.S.A., and we learn that there has recently been a very great increase in the membership of the American Meteor Society, from a report by Mr. Charles P. Olivier on the August meteor campaign (Monthly Reg. Soc. Pract. Astr., vol. vii., No. 6). Attention was mainly given to secure data for estimating the heights of the Perseid meteors. Observers situated at four stations arranged to maintain a watch on the same absolute section of the earth's atmosphere from 12h. to 14h. on each night from August 9–13 inclusive. Two nights (10 and 11) were totally cloudy. In the present report Mr. Olivier gives a summary of the observations made at one of the stations (Leander McCormick Observatory). The maximum of the shower occurred on August 12, whilst August 13 was notable for the brilliancy of the meteors seen. The publication of the complete results obtained will be awaited with considerable interest.

RADIAL VELOCITIES AND DISTANCES OF THE STARS.—The very puzzling relationship between the linear velocities of the stars and their spectral type has given rise to much speculation. Eddington's suggestion that the relationship is fundamentally between *distance* and velocity received support from the results obtained by Kapteyn for the K-type stars. Dr. W. S. Adams has recently extended the analysis to stars of the other main types (Proc. Nat. Acad. Sci., vol. i., p. 417; also *Astrophysical Journal*, November), with similar results—stars of types F, G, K, and M, having large proper motions, have also high linear velocities. For stars of types B and A the velocity difference is not so marked, but the range of proper motion is also considerably less.

The low average velocity of the distant stars of types F to M—stars of high absolute luminosity—together with the exceptionally great average radial velocity of the observed absolutely faint stars, stars of probably small mass, is held to favour Halm's hypothesis of the equipartition of energy among the stars.

A NEW ASTRONOMICAL PUBLICATION.—Under the ægis of the French Committee of Astronomy there has recently been launched a new periodical, entitled *Journal des Observateurs*. The editorial duties have been assigned to M. Henry Bourget, director of the Marseilles Observatory. The journal is to be strictly and exclusively devoted to the publication of observational matter concerning—for the present—planets and comets. The first number contains series of observations of comet Mellish (1915*a*), from Lyons, Algiers, and Marseilles, together with observations of minor planets. Numbers are to be published as occasion demands, and the terms of subscription are 25 francs per volume of twenty parts. We wish the new venture every success.

LANCASHIRE SEA-FISHERY INVESTIGATIONS.

NOTWITHSTANDING the fact that investigations at sea practically ceased with the outbreak of war, the report of the Lancashire Sea-Fisheries Laboratory for 1914 shows that much useful work was still carried on under the more restricted conditions which the war imposed. As Prof. Herdman points out in his introductory chapter, the present seems an opportunity to concentrate attention upon the cultivation of the shallower seas, and any increase of employment on the seashore or in shallow waters may be of direct and immediate advantage, both to the fishermen and to the country. "Such industries as shellfish cultivation, shrimping and prawning, whitebait and sprat fishing, if extended and exploited judiciously, will add to employment, will increase the food supplies of the country, and may lead to the establishment of permanent industries of a profitable nature."

One of the most useful sections of the report is the memoir by Dr. James Johnstone on the bacteriology of shellfish, which records the results of experimental work on the methods of cleansing mussels from ingested sewage bacteria. The self-cleansing of sewage-polluted mussels by placing them for some days in pure sea-water had previously been demonstrated. The experiments now described deal (1) with the periodic bacteriological examination of mussels from a polluted source, which were laid down either on the shore or in floating tanks in localities where pure sea-water is found; and (2) with similar bacteriological examination of mussels from a polluted source which were kept in sea-water sterilised by the addition of five parts in a million of chlorine. In both cases the number of organisms in the mussels was so far reduced that the shellfish might be safely used as food.

In an appendix to the memoir, Dr. Johnstone gives a more minute and detailed examination of the scientific methods employed in his investigations and of the principles involved, which will be greatly valued by specialists in this line of work.

A second memoir by Dr. Johnstone deals with diseased and abnormal conditions of marine fishes, and forms a substantial addition to his previous work on this subject. The greater part of the memoir is devoted to the description of tumours found in fishes. Both benign and malignant tumours occur, the malignant being rare. All the malignant tumours the author has seen in fishes are sarcomata, due to an excessive growth of connective-tissue and almost always of the subintegumentary connective-tissues. Cases of hæmangioma in the eye of a stickleback and of papillary cystadenoma in a ling are also described.

A paper of high scientific value is that by Prof. B. Moore and Messrs. E. B. R. Prideaux and G. A. Herdman, entitled "Studies of Certain Photo-synthetic Phenomena in Sea-water." In this paper, seasonal variations in the reaction of sea-water in relation to the activities of vegetable and animal plankton are investigated and discussed. It is shown that the alkalinity of the water in the Irish Sea increases in the spring and summer months. This increase in alkalinity is not due to increasing temperature disturbing the equilibrium between the carbon dioxide of sea-water and atmosphere, for the rise in alkalinity clearly precedes in time the rise in temperature. It is caused, the authors state, by photo-synthesis, as is shown by its coincidence in its occurrence with the rapid lengthening of the day in March and the increasing sun's altitude, as also by the great changes in alkalinity which may be produced by exposure of sea-water containing algæ to sunlight.

Other subjects dealt with in the report are the plankton of the Irish Sea, the spawning period of the common shrimp, the whitebait fisheries of the Menai Strait, measurements of the Irish Sea race of herrings, and the variations in the amount of fat in these herrings at different seasons. The report as a whole shows that much valuable work is being carried out, and the Lancashire Sea-Fisheries Committee is to be congratulated upon it

THE ACTION OF GASES ON IRON AND STEEL.

BY a curious coincidence, three out of the eight papers presented at the recent autumn meeting of the Iron and Steel Institute deal with the effects of a gas or its compounds when present in iron or steel. The gases dealt with are oxygen, by Mr. Wesley Austin; nitrogen, by Prof. N. Tschischewski, of Tomsk; and blast-furnace gases, by Mr. T. H. Byrom. The prominence thus given to the question of the action of gases reflects the increasing attention which this subject demands in practice. During most ordinary manufacturing processes our metals are exposed—often for prolonged periods—to the action of gases, and a knowledge of their action is thus of great importance. The subject is, however, beset with difficulties, since in many cases it is not at all easy to prepare alloys containing a given gaseous element in any desired proportion, while even the analytical determination of the nitrogen or oxygen contents of steel is by no means free from doubt and difficulty.

These difficulties are evident in the two papers named above, which deal with oxygen and nitrogen. Mr. Austin's specially prepared "oxygen alloys" contain relatively very large amounts of oxygen, and this makes it difficult to bridge the gap between his laboratory series and even the most highly oxygenated

steels met with in practice. The same difficulty occurs in regard to Prof. Tschischewski's paper, which does not, therefore, set at rest the vexed question whether the very minute quantities of nitrogen which are found in industrial steels—and particularly in those made by the Bessemer process, are really responsible for the injurious effects which are sometimes ascribed to them. It was therefore satisfactory to hear that the whole question of the influence of nitrogen was to be placed on a more satisfactory basis by systematic research under the auspices of Dr. J. E. Stead. Meanwhile, the results of the Russian investigator furnish the best available data in regard to nitrogen in steel. In order to introduce nitrogen into steel, Prof. Tschischewski found it necessary to expose the heated metal to ammonia vapours, since free nitrogen apparently does not combine with iron except, possibly, at very high temperatures. Incidentally, this result is of importance from the point of view of experiments on iron and its alloys at moderately high temperatures, since it indicates that an atmosphere of pure nitrogen would be without action on the material.

Interesting from what is, at first sight, an entirely different point of view, are the results obtained by Mr. Byrom in his observations of the carburising action of blast-furnace gases at temperatures not exceeding 500° C. Hitherto it has been generally held that the carburisation of iron does not take place until the temperature of Ac_1—about 700° C.—is exceeded. The explanation given has been that since iron carbide is not soluble in alpha iron, which can alone exist at such lower temperatures, carburisation would not occur, or, if it did, must remain strictly confined to the surface. Mr. Byrom, however, with the co-operation of Dr. Stead, has shown that in the stream of gases which come from a blast-furnace, iron becomes rapidly carburised, and is, in fact, converted into a carbide of iron so rich in carbon that the presence of a carbide, Fe_2C, in addition to the well-known Fe_3C is suspected. There is, however, a simultaneous increase in the sulphur-content of the material.

The contradiction between these observations and the previously accepted views is not so great as at first sight appears. An examination of the iron after partial carburisation by these gases at once shows that there really is no diffusion of the carbides through the iron, but that the carbide is formed *in situ* by the interaction of the gas, which has diffused through the iron as such, and the iron immediately in contact with it. It is, further, very doubtful indeed, if it has not actually been disproved, whether any such carburising action would occur if the blast-furnace gases were replaced by pure carbon monoxide; it is almost certain that some of the other gases present in the blast-furnace, such as the carbon oxy-sulphide which Mr. Byrom suggests, play an important part in the reaction as "catalytic agents."

This consideration also affects a theoretical bearing to which attention was directed by Prof. Carpenter in the discussion on Mr. Byrom's paper. The point in question is that of the supposed "meta-stable" character of iron carbide. This conception of the nature of the carbide, and its tendency to dissociate into free carbon and iron, lies at the base of the widely accepted equilibrium diagram of the iron-carbon system. If, however, it could be shown that iron and carbon could unite to form iron carbide at these moderate temperatures, then the idea that the carbide is meta-stable at these temperatures would have to be abandoned. As was pointed out by Dr. Rosenhain, however, the results obtained by Mr. Byrom do not at all establish such a fact; all that they do establish is that in the complex system consisting of iron, carbon monoxide, and a number of other gases, iron carbide can be formed at temperatures in the neighbourhood of 500° C. But it is quite possible, and even probable, that the equilibrium ranges of such a substance as iron carbide may be very considerably altered in the presence of three or more components. The fact that the presence of another component does frequently alter or depress the lines or surfaces of equilibrium in a thermal diagram is well known, and it may be that what is frequently termed "catalytic action" is simply due to such an effect. Therefore, although interesting and important in themselves, Mr. Byrom's results appear to leave the question of the stability or otherwise of iron carbide much where it was before.

The two papers on the nitrogenisation and the carburisation of iron brought out one common feature of great interest. In both it was shown that the gases penetrated along the boundaries of the crystals of the metal and from these spread into the masses of the crystals along the cleavage planes. Both the carbide and the nitride of iron exhibit the distribution typical of such action most clearly—so much so that attack by means of gases would seem to offer possibilities for the study of the crystallographic data of the material by rendering visible certain cleavage planes.

The phenomenon is, however, interesting in itself, and demands explanation. Such an explanation was offered in the discussion, on the basis of the "amorphous cement" hypothesis of Dr. Rosenhain. If the crystals are held together by thin layers of amorphous metal, then these layers would naturally serve as channels for the diffusion of gases. Liquid metals are well known to possess greater powers of dissolving gases than the solid material, and the "amorphous" condition is at all events closely akin to the liquid phase, even if it is not entirely identical with it. Even iron carbide would be soluble in the amorphous layers, and its distribution along the crystal boundaries would thus be readily explained. On the cleavages also, traces of amorphous metal might well be left as residues of the amorphous metal which would—according to the views of Beilby and Rosenhain—be formed on those planes whenever the metal was "wrought." It will be seen that these results of experiments on the action of gases throw an unexpected sidelight on a theory which is still the subject of controversy; they even suggest the possibility of employing gases as "reagents" for the detection and location of any amorphous metal which may be present in a specimen.

Finally, it should perhaps be stated—although it is obvious enough—that the results contained in these papers are of some considerable practical importance, but in this place they have been regarded rather from the point of view of scientific interest.

SCIENCE AND CIVILISATION.[1]

THE San Francisco meeting has been appointed with the double purpose of encouraging the development of science in the Pacific region and of uniting with other organisations in celebrating the completion of the Panama Canal. There could scarcely be a better illustration of the relations of science to civilisation than the canal supplies. This great waterway has been constructed, not so much by the potency of our national wealth in gold, not so much by the wonderful engineering and administrative ability which we all delight to honour, as by the victory of pure and applied science over the sources of malarial and yellow fever infection. Three centuries

[1] Address (slightly abridged) to the American Association for the Advancement of Science, delivered at the San Francisco meeting, August 2, by the President, Dr. W. W. Campbell.

of research in the various branches of biology, as pure sciences, inaugurated by Vesalius's anatomical dissections (about 1530), by Harvey's discovery of the circulation of the blood (about 1616), by Hooker's introduction of the microscope (about 1665), by Leeuwenhoek's discovery of protozoa (1675), and indeed of bacteria (1687), and continued by a succession of unselfish men whose names are as household words to all biologists, had led up naturally to the mighty contributions of Pasteur, Lister, and Koch in bacteriology. Then followed, logically, the investigations of Reed and others upon yellow fever infection, and of Laveran, Manson, and Ross upon malarial infection. Except for such voluntary tests as were made at the peril of their lives by Drs. Lazear and Carroll in Cuba in the year 1900, in which Lazear paid the extreme penalty of death from yellow fever, and for the tests made by many other volunteers, especially in Italy, as to malaria, in order to determine the precise conditions under which certain mosquitoes transmit these diseases, the canal would not be complete to-day. Our Government might not, in fact, have started upon its construction; or, if the Government had started blindly to lead the blind, there would have been failure as miserable as that recorded by the French canal company, and for the same reason. We forget unpleasant facts quickly; for example: that of thirty-six brave French nurses who came together to the canal zone, only twelve returned to France; that out of eighteen ambitious young French engineers who crossed the Atlantic on the same ship for service on the canal, only one was alive at the end of thirty days; and that the labourers died by the thousands. The project of constructing the canal was surrendered to an unknown enemy. Let us assume, however, that such sacrifices had prevailed in their purpose, and that the canal had been completed in accordance with the engineering plans. With malaria and yellow fever still ruling in the canal zone, and with the zone as a centre of infection for all ports of the Atlantic and the Pacific, would a completed canal be a valued asset to commerce, or would it be a constant menace and a nuisance? Let Memphis and Havana and New Orleans answer. A grateful people could worthily erect by the Golden Gate a monument to Lazear, who gave all that he had to make the construction of the canal possible, and to make the completed canal of permanent value.

The minds of all thoughtful people are dwelling daily upon another great application of science—the European and world-wide war. During the past twelve months the resources of the leading European nations have been applied with the utmost intensity to purposes of destruction—to turning the hands of civilisation backward. The most recent discoveries in science and the latest inventions are utilised in dealing death to the foe, from the air, from the land, from the sea, and from under the sea. It is a fact that the efficiency of the engines of death in all nations is measured by the state of science in those nations. By way of comment upon this lamentable truth, what shall we who advocate the advancement of science say for the faith that is in us? The prostitution of science to the killing and crippling of men is indeed an ugly fact, but its results are negligible in comparison with the daily ministrations of science to the people's needs. A conflagration may burn a great city; but the inhabitants of that city do not ask that fire, the most useful servant of the human race, shall be banished from their daily lives. The remarkable advance in the civilisation of the leading nations during the past four centuries has been due, chiefly, to the daily and hourly influences of accurate knowledge and scientific method; and this advance has been made not by virtue of, but in spite of, wars and the implements of warfare. In this connection, let us note that the scientific spirit is all but unknown among the Turks, the Moroccans, the Mohammedans in general, the Hindoos, the Egyptians, the Chinese. Amongst all these peoples, comprising three-fifths of the human race, can any one of us to-day recall the names of three men who have contributed appreciably to the advancement of science in the past two centuries? The very limited introduction of scientific method into their countries is the work of alien governors or alien influence. The unscientific nations are threatened with absorption by their more scientific neighbours, not so much because they do not invent or perfect the most powerful cannon, the sturdiest Dreadnought, the speediest aeroplane, or the subtlest submarine, as because the scientific peoples forge ahead of them in the arts of peace, in the modes of thought, in the affairs of daily life. The unscientific peoples are without influence in the world, not because they are unwarlike—the Turks and essentially all Mohammedans are warlike enough to suit the most exacting—but because they are lacking in the every-day efficiency which accompanies the scientific spirit.

The term science may be defined in several ways. From the point of view which interests us to-day, we may say that science is the relationship of cause and effect. Wherever we observe an effect there has been a cause; wherever causes are operating there will be effects. The same causes, acting under precisely the same conditions, will produce precisely the same effects. This is the experience of every investigator in every subject, and no one has the slightest reason to doubt the correctness of the principle. There is no room for the operation of the arbitrary and the capricious; in fact, the arbitrary and the capricious do not exist in nature. If in one case out of a hundred the result which interests us is different from what we had expected, we may rest assured that in this one case some change occurred in the forces acting; a new force entered, an old force became inoperative, or the relative intensities of the active forces changed. When we do not understand why certain events occurred it means that we do not understand the forces which acted to produce the events. The correct explanation of the events means that we have isolated the causes and have been able to express the laws of their action.

The forces which have interested mankind range from those cosmic forces which operate on a scale so stupendous that we have no control over them, down through those forces which we can control to a limited extent, and on to those which are absolutely subject to human control. We are not able to limit or to increase the output of the sun's heat, and we cannot guide the movements of the comets, planets, and stars in their orbits. We do not know how to stay the wind and the rain, but we can apply them, in a limited degree, to our purposes, and we can do much to protect ourselves from their injurious effects. The forces which govern the daily life of the individual, the community, and the nation, and which govern the relations of individuals, communities, and nations to each other are, with rare exceptions, either absolutely under human control or such control is a hopeful aspect of the near future. These forces are the means to certain logical ends, and we cannot question that they also operate unerringly according to law. Whether they shall be applied for civilisation or against civilisation is for man to decide. The automobile may be used to bring the physician on an errand of mercy, or to hasten the robber to a place of concealment and immunity. High explosives will cut a canal through the Culebra ridge, or deal destruction from a 12-in. shell. The American army may establish local self-government in Cuba from the

highest of humanitarian motives, or it may wage a war of conquest on a weak neighbouring country from the low motive of increasing the power of human slavery as a national institution.

From our experiences upon the earth we have learned to place faith in certain simple laws of nature, amongst which are the following:—

(1) Every particle of matter attracts every other particle of matter, in accordance with the law of gravitation.

(2) Heat always flows from a hotter body to a colder body.

(3) The volume of a given quantity of gas or vapour is a function of the temperature and pressure to which it is subjected.

If a rifle, elevated at a certain angle above the level surface of a lake, gives a certain muzzle velocity to the bullet, the bullet will describe the curve which the law of gravity says it should describe, and strike the water where the law says it should strike, provided we take into account two small factors that are also acting—the resistance of the air and the rotation of the earth.

A red-hot cannon ball and a red-hot bullet, thrown into a great bank of snow, will both cool down to 32° F.; the great cannon ball slowly and the little bullet rapidly.

A rubber balloon containing a given quantity of hydrogen gas can be so proportioned that if thrown from a high tower on a hot summer day it will expand and rise, or on a cold winter day it will contract and fall.

If a comet, a hundred million miles away, more or less, is observed very accurately as to its direction from us to-night, again next Monday night, and a third time in two weeks from to-night, Newton's law of gravitation will enable us to determine the curve in which the comet is travelling around the sun, and to say where the comet may be seen three months or six months later.

The great stars and the small stars radiate their heat energy into surrounding space: the great stars cool off extremely slowly, and the small stars comparatively rapidly. Examples of this principle, it is believed, are the great sun, on one hand, its volume 1,300,000 times the earth's volume, its surface temperature higher than 10,000° F., and its interior temperature immensely higher yet; and the little earth, on the other hand, cool on the surface and relatively cool in the interior.

As the great gaseous suns radiate their heat energy unceasingly into surrounding space, they undoubtedly grow slowly smaller under the force of their own internal gravitation, which strives constantly to pull each molecule of gaseous matter to the centres of the stars.

There is every reason to believe that the three simple laws which we have quoted and illustrated are fundamental, and operate invariably throughout the stellar universe.

And so it is, so far as human experience has gone, with all the laws of nature.

To some people this infallible and universal obedience to law—the strict accountability of effect to cause—seems a hard and cruel fact and counter to idealism in its various forms. This is a hasty and faulty view. It is the cause-and-effect relationship which gives us something dependable upon which to build our civilisation. The recognition of this principle, whether conscious or unconscious, is the chief difference between modern civilisation and the civilisations which prevailed in the days of the inquisition and of the Salem witchcraft. Looking at the subject from the idealistic point of view, the conception that all matter in the universe is endowed with the property of obeying law—unalterably obeying law—is incomparably grander than the conception of one law prevailing here, another law prevailing there, of irresponsible caprice operating both here and there.

History affords no more remarkable phenomenon than the retrograde movement in civilisation which began with the decline of Roman power and continued for more than a thousand years, approximately to the epoch of the Borgias, Columbus, and Copernicus. There had once existed a wonderful Greek civilisation, but for twelve or fifteen centuries it was so nearly suppressed as to be without serious influence upon the life of the European people. Greek literature, one of the world's priceless possessions, not surpassed by the best modern literatures, was as complete two thousand years ago as it is to-day. Yet in the Middle Ages, if we except a few scattered churchmen, it was lost to the European world. A Greek science never existed. Now and then, it is true, a Greek philosopher taught that the earth is round, or that the earth revolves around the sun, or speculated upon the constitution of matter: but excepting the geometry of Euclid and Archimedes, we may say that nothing was proved and that no serious efforts were made to obtain proofs. There could be no scientific spirit in the Greek nation and civilisation as long as the Greek religion lived and the Greek people and Government consulted and were guided by the Greek oracles. If there had been a Greek science, equal in merit with modern science, think you that stupidity and superstition could have secured a strangle hold upon Greek civilisation and have maintained a thousand years of ignorance and degradation? Intellectual life could not prosper in Europe so long as dogma in Italy, only 300 years ago, in the days of Bruno and Galileo, was able to say, "Animals, which move, have limbs and muscles; the earth has no limbs or muscles, therefore it does not move"; or so long as dogma in Massachusetts, fewer than 250 years ago, was able to hang by the neck until dead the woman whom it charged with "giving a look toward the great meeting-house of Salem, and immediately a demon entered the house and tore down a part of the wainscoting." It was the re-birth of science, exemplified chiefly by astronomy, and secondarily by medicine, which gave to the people of Europe the power to dispel gradually the unthinkable conditions of the Middle Ages.

Shall we try to estimate what astronomy, an ideal science, sometimes called an unpractical science, has done for mankind? We shall not dwell upon its so-called practical applications, such as the supplying of accurate time, the sailing of ships precisely to their destinations on the other side of the great oceans, the making of accurate maps of the continents and islands, the running of boundary lines between nations, the predicting of times of high and low tides, and so on; we shall consider only the pure knowledge side of the subject.

Conceive of the earth as eternally shrouded in thick clouds so that the earth's dwellers could never see the sun, the moon, the stars, and the nebulæ, but not so thick that the sun's energy could not penetrate to the soil and grow the crops. Under these conditions, we might know the earth's rock strata to the depth of a mile or two, we might know the mountains and the atmosphere to a height of two or three miles, we might acquire a knowledge of the oceans, but we should be creatures of exceedingly narrow limits. Our vision, our life, would be confined to a stratum of earth and air only four or five miles in thickness. It would be as if the human race went about its work of raising corn for food and cotton for raiment, always looking down, never looking up, knowing nothing of

the universe except an insignificant stratum of the little earth. This picture is only a moderately unfair view of life as it existed on our planet four hundred years ago, before the days of the telescope, the spectroscope, and the photographic plate, and before the days of freedom of speech and thought. The earth is no longer flat, supported on the back of a great turtle which rests upon nothing; it is round, and we know why; and it revolves around the sun in exact obedience to law. The stars are not lanterns hung out in the sky by angels at night; they are suns, hundreds of millions of suns, each on the average comparable in size to our sun. Exists there an intelligent man in the world whose thoughts, every day and many times a day, are not adapted to these facts? Who can estimate the value of this knowledge to the human race?

We have not yet seen little earths revolving around any stars except our own, nor do we know that intelligent beings live upon such planets and are looking down towards our system and seeing our sun as a little star in their night sky; but everybody now holds as absurd the view that our star is the only one of the hundreds of millions of stars which has little planets revolving around it, or that our earth is the only one that is inhabited by intelligent life. Can there be a more inspiring thought than that intelligent beings are probably living here and there throughout the universe, in whatever direction we may look? The spectroscope has shown that the chemical elements which compose the earth are also the constituents of our sun and of the other suns. We have no reason to doubt that the chemistry of the earth is the chemistry of the universe. The spectroscope and the photographic plate are telling us of the close relationship of the nebulæ to those stars which we call the youngest stars, of the young stars to the middle-aged stars, and of the middle-aged stars to the old stars. We cannot doubt that the stars are growing older, as we are growing older, as everything in nature is changing and growing older, and in accordance with the same laws which govern the changes on the earth. The student of double stars finds that the movements of the two components of a distant double star system are in accordance with the law of gravitation. Every particle of our experience leads us to believe that the reign of the laws which control our everyday affairs is universal; that the strict relationship of cause and effect applies throughout the stellar system. Does not this broad and stable foundation give valued confidence to those who are building the structure of the other sciences, the structure of everyday life, the structure of civilisation?

It is now quite difficult to find a subject that is not being studied scientifically somewhere by somebody. It is this fact which accounts for the remarkable progress of civilisation in the past half-century, and especially in the last thirty years. With rare exceptions, all important interests are pulling together for the welfare of mankind, and their efforts are effective because they are advancing over the firm foundation of scientific method. Every branch of science, every nation's literature and art, every element of "religion pure and undefiled," every element of commerce conducted upon the dignified basis of mutual respect and mutual profit of buyer and seller, is a contributor to the forward movement. It would be a pleasure to support this thesis by reference to definite contributions in many subjects, but time is available for only a few accomplishments of the past and a few needs of the future.

The discoveries in preventive and curative medicine undoubtedly rank amongst the most valued contributions to civilisation in the entire range of scientific research. I am disposed to place the names of Louis Pasteur, Joseph Lister, and Robert Koch very high on the list of the world's great benefactors. Pasteur was a professor of chemistry whose first investigations lay in the domain of abstract chemistry, and his subsequent successes, which put the world in the way of preventing and eradicating all infectious diseases, proceeded naturally from his application of the methods of research in pure chemistry to the problems of fermentation. He proved that wine, beer, and milk ferment and turn sour because minute organisms, always present in the atmosphere, invade these liquids, multiply enormously, and corrupt them. Break the skin of the grape, the atmospheric parasites enter the wound, and fermentation develops. Exclude the air, or destroy the germs in the air, the wound in the vegetable structure remains clean and healthy indefinitely.

These discoveries by Pasteur attracted the immediate attention of Lister, who applied them in surgical operations. Antiseptic surgery, one of the most glorious works of man, is the result.

Pasteur proceeded upon the theory that just as fermentation is the work of foreign organisms, so certain diseases of animal life are the work of microbes which have entered the body of the sufferer. His first successes in preventive medicine related to cholera in the French fowls, and anthrax in the French cattle and sheep. His treatment reduced the death-rate of the fowls and animals from about 10 per cent. to fewer than 1 per cent. The great British authority, Thomas Huxley, estimated that the savings in these sources of wealth to the French nation in two decades were sufficient to pay the war indemnity of 1871. Proceeding further along the same lines, Pasteur inaugurated the curative treatment of hydrophobia. The fatalities from this horrible malady dropped suddenly from nearly 100 per cent. to fewer than 1 per cent. Do we realise that this was only thirty years ago?

In the next three decades followed the preventive and curative treatments by several renowned investigators for diphtheria, tetanus, yellow fever, malaria, spinal meningitis, typhoid fever, and other maladies. Progress has been notable in the treatment of tuberculosis, bubonic plague, cholera, typhus fever, and sleeping sickness. There are faith and hope in the future as to preventives and cures for tuberculosis, scarlet fever, measles, and cancer. The practice of extreme cleanliness and the use of anæsthetics in surgery have enabled surgeons to reach hitherto inaccessible parts of the body, to reduce the death-rate enormously, to diminish the suffering of the patient, and to afford health and strength after healing. Wonderful operations upon the brain, upon intestines, upon severed nerves, veins, and arteries are now performed. The general health of communities has been improved by the theory and practice of cleanliness and fresh air. The average length of life has increased by many years since the principles discovered by Pasteur have been applied. The increase has been greatest for children and women and those not in robust health, but it has also been great for those healthy men who have been accepted as risks by the life insurance companies. Life insurance business has been based upon mortality tables which represented the expectation of life under the relatively unhealthy conditions which existed a half-century ago. Those tables do not fit modern conditions. The number of deaths is now smaller than the insurance tables predict. This means that the actual cost of insurance is correspondingly reduced. The statistics for the saving from this source are not readily available. It can be said, however, that the increase in the duration of the lives of those healthy men who carry insurance, during the

past thirty years, has meant a money saving greater in amount than all the expenditures ever made by the universities, research institutes and individuals in support of medical investigation. This reckoning does not include the saving of the lives of women and children, nor take into account the economic values of the lives of the men, women, and children saved. The reckoning likewise omits the vastly greater factor of human happiness which proceeds from healthful and complete family life.

We have referred at considerable length to progress in medical science and have said that this progress followed naturally from Pasteur's investigation of fermentation as a problem in pure chemistry. We do not intend to detract in any sense or to any extent from the glory of Pasteur's work, from the glory of Lister's, Koch's, Roux's, Behring's, Ross's, Ehrlich's, and Flexner's services, when we record the simple fact that the structures which they erected and which mankind is finding of incalculable value were built upon the broad and firm foundations which the earlier investigators in biology and chemistry had made ready.

The development of the other subjects which have become so vital in modern life have essentially paralleled that of biology, chemistry, and medicine.

It is so well known as to be a trite subject that electricity was studied a full century, following Volta and Galvani, before it was seriously applied to the arts. It is not so well known that the immense value of electricity in current life, as applied by the electrical engineers, is due chiefly to the work of two men: Faraday, in the Royal Institution of London, who, studying electricity as a pure science and with no apparent thought for its possible applications, discovered the principles of magneto-electric currents, upon which all modern dynamos and transformers, electric lighting, telephoning and telegraphing, and the transmission of power depend; and Maxwell, of Cambridge University, who wrought Faraday's results into a foundation of complete and rigorous theory upon which future electrical engineers might build.

The X-rays and radium are the products of research in pure science, and quite regardless of so-called utility; yet what is to-day more useful than the X-rays, and what promises greater usefulness than radium and its related radio-active substances?

Pure science studies in the broad fields which we may call botany and chemistry have made scientific agriculture possible. We cannot exaggerate the importance of science in farming for the future of the human race.

A few months ago the people of the Pacific coast acquired the power of telephoning directly to Atlantic coast points. Newspaper accounts made much of the fact as a great advance, and so it was; but the newspapers left Hamlet out of the play. Improvements in the insulating system, to reduce losses of current along the line, were involved; but Bell at New York and Watson in San Francisco inaugurated the long-distance conversations by using the same transmitters and receivers which these same gentlemen had used in the beginning of telephoning, in 1876, over the line two miles long between Boston and Cambridge. The great improvements in the thirty-nine intervening years lie elsewhere in the system. It is possible for San Francisco to talk with New York and Boston, and at quite reasonable expense, because Prof. Pupin, of Columbia University, as a result of systematic study, construction, and test, discovered that by placing his invention, the so-called "loading coils," at certain appropriate intervals in an electric line, thus making what electricians call a suitable balance between inductance, electrostatic capacity, and resistance, the current could be compelled to go through to its distant destination with little loss of strength. Pupin's loading coils are inserted at frequent intervals in the San Francisco-New York line. It might be possible to construct a line without the Pupin coils which would let us talk directly with New York, but the installation expenses for very large copper wires and other costly items would be so high as to impose prohibitive tolls. The happy result has been reached because the telephone company combined an exceedingly liberal and far-seeing policy with the latest discoveries in electricity as a pure and applied science; and all concerned are entitled to receive the grateful thanks of the Pacific and Atlantic peoples.

Wireless telegraphy has been a priceless servant to those whose friends go down to the sea in ships. It has averted many frightful disasters in the past decade. This branch of electricity was made possible by the researches of the lamented Hertz and others who studied the properties of electrical waves as we study the light-waves from the nebulæ—from the point of view of pure knowledge.

While the foundations of the sciences have, for the most part, been laid under the auspices of the universities and the special research institutions, it is usually the combination of men of science and successful men of affairs which makes the sciences useful to the people in general, and therefore great factors in the advancement of civilisation. To mention only one subject, electricity; we cannot compute the world's indebtedness to the pioneers, Volta and Galvani, or to the great developers of the subject, Faraday and Maxwell; but it is a fact that electricity did relatively little for mankind in general before the year 1865. The world is unable to compute its indebtedness to Edison, Bell, Marconi, and other great inventors and business men combined, who have brought electricity to everybody's house and office, to every factory, to every village, to every ship as an obedient and ever-ready servant. That these gentlemen have made commercial successes of their ventures seems to have caused certain persons to lose interest in them as men of science. I have no sympathy with that point of view. Only those who have tried it can know how much courage is required to risk everything in a new venture, how many hours of day and night are given to thought of the subject from all possible angles, how unceasing must be the maintenance of discipline in great business organisations. Not only is financial success doubly earned, and most desirable as an incentive to the succeeding generations, but financial success is absolutely synonymous with making the subject useful to mankind. It is a fortunate fact that there are Stephensons and Fultons, Edisons and Marconis, as well as Newtons and Laplaces, Darwins and Helmholtzes. The latter have laid the foundations broad and deep, but the former have erected superstructures upon these foundations which the civilised world is using every minute with great advantage. And, further, these structures, which are visible in the daily life of the people, are the incentives which lead to the provision of splendid opportunities for the extension of the foundations. The value of science as a factor in advancing the race depends at least as much upon the applied as upon the theoretical side. There can be no durable structure without the foundation, but the foundation alone, possessing wonderful potentiality, is largely a latent force. History confirms the view that real progress in civilisation is most rapid when applied knowledge is not too far behind theoretical knowledge.

The human race needs above everything else the conviction that the principles of science rule everywhere, and that the problems of personal and national life are not solved so long as any important forces are

ignored. The need is especially great in our own country, where isolation from other countries and the existence of immense reservoirs of natural resources have let us seem to keep up with international progress in spite of our wasteful and inefficient methods. It were well to recognise that entry upon world affairs, which we cannot long avoid, will reveal costly weaknesses.

The appeal of science for the adoption of scientific methods in the daily life of the people, in the governments of community, State, and nation, in the settling of international questions, is not an appeal for efficiency at all costs. The life that is for ever bent over the exact equation, two plus two are four, a life that tries to express all its experiences in equations equally exact, is liable to be narrow, distorted, unhappy, and misspent. The man who worships scientific efficiency, like the man who is a slave to gold, or the man who pushes his religion too far, may acquire a harsh and selfish view of life; pity and charity may drop out of his vocabulary.

Our appeal is for the scientific method of treating the problems which are before us for solution. The scientific method is that which takes account of all the forces acting. It is therefore the just method. It is in full harmony with the golden rule, "Do unto others as you would have others do unto you." It is, if you please, in full harmony with the spirit of Christ. Support is given to research by the Governments and by generous men and women in order that the truth may be found and be made available in the service of mankind. The investigational laboratories of the universities, the observatories, the private institutions for research, have precisely these ideal purposes, and no other purpose. The various activities of the world contribute to the advancement of civilisation in proportion as they contain the ideal and the unselfish. That which is purely practical, containing no element of idealism, may sustain existence and to that extent be valuable, but it does not civilise. I believe it is the idealism of pure knowledge, the idealism in applied knowledge, the idealism in industry and commerce, the idealism in literature and art, the idealism in personal religion, which leavens the life of the world and pushes forward the boundaries of civilisation.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The Herbert Spencer Lecture for 1916 will be delivered by Prof. J. Mark Baldwin, honorary professor of the University of Mexico, in the lecture-room at the University Museum on Wednesday, March 15, 1916, at 2.30 p.m. The subject of the lecture is not yet announced.

The Vice-Chancellor has just issued a memorandum dealing with the present position of University finance. He points out that by voluntary contributions from professors, examiners, and other officials, supplemented by grants from various funds and certain windfalls, the estimated deficit of 12,000*l*. for the present year has been met, and a small credit balance left to be carried over for next year's working. This, however, does not make the position secure. The deficit for 1916 can scarcely be less than 12,000*l*., and it is shown that the University cannot count on a repetition in full of the voluntary contributions or of many of the grants. The Michaelmas term matriculations have fallen from 580 in 1914 to about 250 in the present year, and there seems no prospect of any increase in the number of undergraduates during the war. The heads of departments have made considerable retrenchments, but it is not easy to carry out a very drastic policy in this direction. It is pointed out that in some cases the needs of medical students prevent the closing of a department, and in several of the laboratories important Government work is being carried on.

IT is stated in *Science* that by the will of the late Mr. A. F. Eno, his residuary estate, which may be very large, is bequeathed to Columbia University.

THE eleventh report of the University of Leeds has now been published. It has been found desirable that the annual report should in future appear in the autumn immediately following the close of the financial year, and consequently the present report covers the two sessions 1913–14 and 1914–15, and records the work of the University to September last. Every department of the University has been affected by the war, and the report is an inspiring record of the patriotic response of the staff and students to the call to assist the country in the great struggle. Since the beginning of August, 1914, 415 members of the Leeds University contingent of the Officers Training Corps have received commissions. In addition to this, a large number of the members of the University have joined the Army and Navy and are serving in the ranks. About one-third of the members of the teaching and administrative staff, and about the same proportion of the undergraduates who were in residence at the University in the session 1913–14, are now on active service. The roll of the members of the University on active service with his Majesty's Forces since the outbreak of the war now includes 917 names. There had been up to the date of the report sixty-six casualties among the members of the University serving with the Forces of the Crown. The University records with sorrow and pride that twenty-eight of its members have fallen in action or from the effects of wounds or poisonous gas. Seven members of the University have received military distinction.

ALL admit that the first duty of this country is to bring the war to a successful conclusion from the point of view of the Entente. The matter of paramount importance is to supply all the needs of the Army and Navy, and no unnecessary obstacle to the success of Lord Derby's recruiting scheme must be tolerated. But the war must end, and peace will bring with it difficulties to be overcome which will rival in magnitude the task of completely vanquishing our enemies. Problems will arise in connection with the health and physique of the nation which will tax the resources of the country's medical service to their utmost limit. The clash of arms will be succeeded by an equally deadly industrial competition. The reconstruction of the appalling devastation will call for all the resources of men of science and qualified administrators. It behoves us, therefore, to use our available men with a wise economy in view of the many and varied duties in front of the nation. Special ability in medical or other science, in technology, in everything, must be utilised with prudence. The addition of highly trained men in any branch of knowledge to the ordinary ranks of Army and Navy must be a last resort; and among the men who are added to His Majesty's Forces from time to time those who have graduated at a university, or have been highly educated in some other direction, should be marked out for commissions or special service. There are many students of military age in medical and other colleges whose duty to their country presents difficulty, and the case of medical students has been discussed widely recently. It has been decided that medical students in their first, second, and third years should be encouraged to join the combatant forces of the King, and presumably this applies to other students. The fourth and fifth year students, it has been suggested,

should serve in the Royal Army Medical Corps. It may be hoped that students of similar standing, who have qualified themselves in various branches of science and technology, will be found suitable places in other branches of the Services, where their special knowledge will be used to the best national advantage.

THE appeal issued last July from the Office of the Board of Education for books to supply the needs of the 4000 or more British civilian prisoners interned in the concentration camp at Ruhleben in Germany met with a hearty response. More than 2000 volumes, mostly standard works, were contributed, and forwarded to Ruhleben. A second appeal has now been received from the camp for more books, and in giving publicity to it the Board of Education desires to thank all those who responded to the original request, whether for offers of books or of money. Under the auspices of a Camp Education Department a school and a science and art union have been organised at Ruhleben, which now have numerous classes, and some 150 lecturers and teachers, and 1500 students, divided into nine departments, which include two in engineering, and one each in mathematics and science, elementary physics, and navigation. The necessary funds for the educational work carried on at Ruhleben are raised by voluntary contributions among the prisoners themselves, and no prisoner is debarred by lack of funds from sharing in the advantages of the camp school. In responding to the appeal for additional books of an educational character it is requested that intending donors will, in the first instance, fill up and return a form which will be supplied on application. A careful selection will then be made, and notified to the donor, of the books suitable for despatch (through the Board of Education) to Germany, so as to comply with the very strict regulations which govern the transmission of literature to the camp. All communications on the subject should be addressed to Mr. Alfred T. Davies, Board of Education, Whitehall, London, S.W. Envelopes should have the word "Ruhleben" written in the left-hand corner.

THE confident prediction in our note last week on the articles in recent issues of the *Morning Post* on British universities and the call to arms, that when particulars of other than English universities were forthcoming it would be found that a similar satisfactory response had been made by Wales, Scotland, and so on, is borne out by the third article published by our contemporary on November 23. Taking the three constituent colleges of the University of Wales, the article shows that Bangor has about 230 students serving, and that five have been killed; that Aberystwyth has 284 in the forces, and that eleven have been killed or are among the missing; and that Cardiff has about 285 serving. One of the inevitable effects of the flocking of the students to the Colours has been a decrease in the number of candidates for examinations. Thus, while in June, 1914, the candidates for initial degrees numbered 1017, the number fell this year to 790. Generally speaking, the decrease in the attendance at the Scottish universities since the outbreak of the war, though very marked, has not been as large as in some of the English centres of learning. In the case of the University of Edinburgh, up to July 8, when an edition of the roll of honour was published, 853 students were known to be serving with the Colours, besides 2562 graduates and alumni; 62 had lost their lives, and 87 had been wounded. It was recently estimated that 1500 old students and 600 present students of the University of Glasgow were serving with the forces. About fifty are believed to have been killed, and many wounded. Apart from these, about 300 are engaged in munitions work. A number of senior medical students who have been invalided are returning to finish their course at the University, having been specially advised to do so. About 280 students of Aberdeen University are serving with the forces. The casualties at the end of September numbered 15 killed and 38 wounded. Of the graduates, alumni, and students of the University, more than 1300 are on naval and military service, and about 110 are under military training. The response from St. Andrews University has also been satisfactory. The writer of the article had received insufficient information to enable him to deal in detail with Irish universities.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 25.—Sir William Crookes, president, in the chair.—M. **Flack**, O. W. **Griffith**, and L. **Hill**: The measurement of the rate of heat loss at body temperature by convection, radiation, and evaporation. An investigation of the rate of cooling of a surface at body temperature (1) dry, (2) wet, under varying conditions of atmosphere, with the view of elucidating the effects of climate, and of heating and ventilation of rooms on health and comfort. A large-bulbed spirit thermometer is employed of standard pattern—the Kata thermometer; methods of calibrating have been worked out, and a factor determined for each, so that the rate of cooling can be expressed in milli-calories per sq. cm. per sec. Some thousands of observations have been made in still air under varying conditions, and the cooling curves plotted; the theory of cooling detailed is the work of the late O. W. Griffith. Experimental results, independently obtained, agree with theory.—E. W. A. **Walker**: The growth of the body in man. The relationship between the body-weight and the body-length (stem-length). Observations have been made on infants, children, and young persons up to early adult age in order to determine whether any definite relationship could be shown to exist between the body-weight and the body-length. By the term body-length is meant the stem-length measured from the top of the head to the line joining the ischial tuberosities. This measurement corresponds to the body-length in animals, and was chosen in order that results obtained for man might be brought into comparison with those for other animals. The author finds that throughout the period of growth stem-length in man can correctly be expressed as a function of body-weight, and conforms to the formula, $l=k.w^n$; where l is stem-length, w weight, k a constant, and n a power of approximate value $\frac{1}{3}$. For the male the value of n (to two places of decimals) is 0·33, for the female it is 0·32. If the stem-length differ by as much as 16·5 per cent. from the value calculated from the body-weight by means of the appropriate formula, the individual may be regarded as abnormal.—Prof. A. J. **Brown** and F. **Tinker**: The rate of absorption of various phenolic solutions by seeds of *Hordeum vulgare*, and the factors governing the rate of diffusion of aqueous solutions across semi-permeable membranes. It has been pointed out previously that the seeds of Hordeum (barley) are enclosed by a membrane which exhibits the exceptional property of differential permeability. When the dry seeds are immersed in aqueous solutions of most inorganic acids and salts, sugars, etc., water alone passes through their containing membrane; with other classes of solutes, however, such as the phenols, fatty acids, and monohydric alcohols, the solute enters the seeds together with water. In order to learn something of the physical properties which presumably govern the exhibition of differential permeability (only recognised to a marked extent with

living protoplasm and with the coverings of certain seeds), experiments have been made with a series of closely-related organic solutes, viz., phenol, catechol, resorcinol, quinol, and pyrogallol, all of which enter the seeds of Hordeum when in aqueous solution. Experiment appears to justify the conclusion that when the temperatures, osmotic pressures, vapour pressures, and viscosities of a series of solutions of *permeable* solutes are equal, their rates of diffusion across the seed-membrane are inversely proportional to their surface tensions.—F. **Kidd**: The controlling influence of carbonic dioxide. III.—The retarding effect of carbon dioxide on respiration. Researches previously described led to the conclusion that the resting stage of the moist seed is primarily a phase of auto-narcosis induced by tissue CO_2. Inhibition of germination by CO_2 was demonstrated in the laboratory and in the field under a wide range of conditions. *Inter alia*, it was shown that the inhibitory value of a given carbon dioxide pressure diminishes with a rise of oxygen pressure and also with a rise of temperature. These researches have now been carried further to determine if possible the mechanism CO_2-narcosis. The present paper deals with the effect of CO_2 upon the respiratory function. The outstanding result shown is that CO_2 causes a marked retardation of respiration.

Physical Society, November 12.—Dr. A. Russell, vice-president, in the chair.—Prof. J. A. **Fleming** and P. R. **Coursey**: The effect of electric oscillations on the magnegtic properties of iron, investigated by the campograph. In March last Prof. Fleming exhibited the campograph, for photographing and delineating physical curves. Since then the optical arrangements have been improved, and the effect of electric oscillations on the hysteresis and permeability of iron have been investigated with the improved instrument. When an iron wire is taken slowly through a magnetic cycle and a superposed high-frequency magnetising force is also applied, then, if the maximum value of the slowly periodic longitudinal magnetic force does not exceed a certain value, the effect of the oscillations is to increase the area of the hysteresis loop and to increase the magnetisation at the ends of the cycle. If the slowly periodic force has a large maximum value then the hysteresis loop is diminished in area, but the maximum magnetisation remains unaltered. The increase in area of the hysteresis loop is generally less for high frequency than for low frequency oscillations, because in the latter case the oscillatory flux penetrates further into the iron wire. If oscillatory currents are passed along the iron wire whilst at the same time the iron is taken slowly through a longitudinal magnetic cycle with continuous current, then when the oscillatory current has a small R.M.S. value the effects are generally similar to those produced by longitudinal oscillatory magnetic forces. If the oscillatory current is relatively large then their effect is to reduce the hysteresis and magnetisation at the ends of the cycle. This last action is due to the circular magnetisation produced by the longitudinal current, which grips the magnetic molecules of the iron, and prevents their longitudinal colineation and reduces also the hysteresis. The same effect is seen when a longitudinal continuous current is passed along an iron wire. The effect of superimposing on a steady feeble longitudinal magnetic force an alternating magnetic force either by undamped or damped oscillations is greatly to increase the permeability at the ends of the cycle, provided the oscillatory force does not exceed a certain value. Beyond that a diminution sets in.

Royal Anthropological Institute, November 16.—Prof. A. Keith, president, in the chair.—Prof. H. J. **Fleure**: An anthropological analysis of the people of Wales. This paper embodied work by Dr. T. C. James and the author during the past ten years. Remote country districts were selected, and altogether 2500 natives of these districts were examined, thirty points being noted and tabulated for each individual. The results were plotted out on maps, so that the physical characters of the native of each district could be detected at a glance. Centres of dark dolichocephalic people were found around Mynydd Hiraethog, S. Cardiganshire, and in the hill country of Glamorgan and Monmouth. These and other centres were afterwards found to be near prehistoric centres of settlement. A very primitive type was found in the Plynlymon moorland, a poor, isolated district, the head form of this type being homologised with the Blackwater skull type. A type, apparently related to the round-barrow man, but with softened features, is characteristic of the valley cleft from Bala to Towyn and of its branches. It is very distinct physically and psychically from other Welsh types. In districts on the coast, with a pelagic climate, and usually near megalithic remains, is found a dark brachycephalic type, with strong jaws. This may be the "old black breed" found in the Shetlands. There is evidence of a chain of localities occupied by people of this type, extending from S.W. Norway (Arbo) along the shores of the Irish Sea, Brittany, Spain, Italy, to the eastern Mediterranean. This line was considered to be connected with a trade route of the Bronze age. Nordic types, amongst Welsh natives, were noted in certain estuaries and open coast localities, and the possibility of Irish Nordic types being represented in mid-Cardiganshire was discussed. To explain the distribution of Neolithic and other types in Wales, Prof. Fleure maintained that the Neolithic inhabitants had occupied only the higher lying, wind-swept moorlands, and that the thickly wooded river valleys served as barriers to migrating peoples.

Geological Society, November 17.—Dr. A. Smith Woodward, president, in the chair.—J. **Parkinson**: Some observations on the structure of the northern frontier district and Jubaland Provinces of the East Africa Protectorate. A floor of gneisses and schists is overlain on the western side by lavas, including those arising from the volcanoes Kulal, Assi, Hurri, Marsabit, etc., and by probably older lava-fields which together extend as far as long. 39° E. On the south, it was found that the lavas north of Kenya reached the Guaso Nyiro, but that a high gneiss country extended north-westwards from lat. 1° N. and long. 38° E. to within a short distance of Lake Rudolf. Eastwards the coastal belt of sediments proved to be of Upper Oxfordian age and to extend to long. 40½° E., and these were lost southwards under the great alluvial plain of Jubaland. At intervals throughout the alluvial plain disconnected exposures were found of soft calcareous sandstones or limestones, the age of which cannot now be definitely fixed. Evidences of the desiccation of the country were shown (1) by the laks, or water-channels, characteristic of Jubaland, which contained surface-water only during the rainy season and then extremely rarely, if ever, throughout their length; (2) by the presence of fresh-water molluscs in the scarcely consolidated beds of such laks and at other places where now no surface-water is present; and (3) by the presence of wells along fault-lines and in other places where, but for the previous presence of springs, it appears improbable that the natives would have begun sinking.

Linnean Society, November 18.—Prof. E. B. Poulton, president, in the chair.—Dr. E. J. **Salisbury**: Photographic studies of Welsh vegetation. The subject was dealt with under the following heads:—(1) The vege-

tation of the limestone: (*a*) the limestone cliffs; (*b*) limestone pasture, with the dominant species, *Festuca ovina*, accompanied by many of the common chalk-down species. Locally small woods of *Quercus sessiliflora* occur, though usually confined to siliceous soils. (2) The vegetation of the siliceous soils: (*a*) the *Quercus sessiliflora* woods, with associated trees as Betula spp. and *Pyrus aucuparia*. Where the water-content is high, but the soil not acid, Fraxinus becomes common. As a result of felling or exposure *Betula pubescens* may become the dominant tree. The average light-intensity in summer is about 7·6 per cent. of the maximum diffuse illumination outside. The shrub layer is usually poor. The flora of the drier parts largely consists of heath species; in the wetter and more acid parts, *Vaccinium myrtillus* is often abundant; towards the base of the slopes the ground flora is often almost entirely cryptogamic. Epiphytes as *Polypodium vulgar*, *Frullania* spp., and lichens are often abundant. In the valley bottom the *Quercus sessiliflora* woods merge into Alnus woods, with a light-intensity of about 3 per cent or under. (*b*) Scrub chiefly of Cratægus. (3) The subalpine vegetation: (*a*) the subalpine lakes with *Subularia aquatica*, *Lobelia dortmanna*, *Littorella lacustris*, and *Isoëtes*, with absence of marginal vegetation; (*b*) the subalpine pastures (Nardus, Lycopodium spp., etc.).

Zoological Society, November 23.—Dr. A. Smith Woodward, vice-president, in the chair.—Prof. A. **Dendy**: Land-planarians from West Australia and Tasmania. The collection was made by members of the British Association. Three species were obtained in West Australia, all of which proved to be new, and of six species collected in Tasmania, two were described as new.—G. A. **Boulenger**: Snakes of East Africa and Nyassaland, and of north-east Africa and Socotra. Lists were given, with keys to the identification of the genera and species.—G. A. **Boulenger**: A new Amphisbæna and a new snake discovered by Dr. H. G. F. Spurrell in southern Columbia.—C. Tate **Regan**: The morphology of the Cyprinodont fishes of the subfamily Phallostethinæ. The author described the structure of these extraordinary little fishes from Johore, and particularly the differences in the priapium of the two genera he recognised.

CALCUTTA.

Asiatic Society of Bengal, November 3.—H. G. **Graves**: The invention of fire. An endeavour to trace the stages of the "inventive" power of man by which fire was converted to his use. The first advance consisted in the maintenance of a fire by feeding it with fuel; next came the power of carrying fire from place to place, and then followed the ability to originate fire. The subject is treated in view of the very low mental powers of early man. With analogies drawn from the development in the manufacture of matches, which originated less than a century ago, it is shown how difficult it is to apply the inventive faculties, and afterwards how easy it is to minimise the importance of any past advance in view of knowledge at the moment. —S. C. **Mitra**: Demon-cultus in Mūndāri children's games. The theory is discussed that a goodly number of European children's games and a few North Indian games, of the well-known "blind man's buff" type, are survivals of demon-worship. It has been suggested that the blindfolded player represents the masked demon who tries to catch the rest of the players, while the latter try to evade being caught. The mask was unprovided with eyeholes either for making the catching more difficult or for warding off the "evil eye" of the demon during the imitation of his activities. It is urged that the demon's attempt to catch the rest of the players and the latter's evasion of his efforts to seize them cannot certainly be called relics of demon-worship. It is suggested that the games are not survivals of demon-worship, but embody vestiges of the demon-lore of primitive times. There appears to be only one game—the "Jack-fruit game," played by children among the Mūndās of Chhota Nagpore—which embodies a travesty of demon-worship.

CAPE TOWN.

Royal Society of South Africa, October 20.—Dr. L. Péringuey, president, in the chair.—E. J. **Goddard** and C. S. **Grobbelaar**: Description of a South African species of Pelodrilus. This is the first record of the genus Pelodrilus in South Africa. The specimens were obtained from Sneeuw Kop, near Wellington, at a height of about 4500 ft. The genital pores were distinctly made out. The occurrence in South Africa is interesting, as the genus has a distribution restricted to the Antarctic region.—S. H. **Haughton**: Preliminary note on ancient human skull remains from the Transvaal. A description of the skull remains found at Boskop, Transvaal, and of the manner of their occurrence. The remains consist of the greater part of the skull-cap, a temporal bone, and a portion of the lower jaw. No estimate can be given as to their age. The bones are fossilised, and were found embedded in a subsoil which overlay and partially consisted of the lateritic "ouklip" characteristic of some parts of the Transvaal. The skull-cap is the longest known, with the exception of that of La Chapelle-aux-Saints. Its greatest affinities are with the skulls of the Cro-Magnon type—a Negroid type which lived in southern Europe after that of Neanderthal. The back of the skull is elongate, a feature displayed both by the Neanderthal man and the Cro-Magnon man, while the forehead and anterior half of the skull agree with the Cro-Magnon and Bantu types, and not at all with the Neanderthal. The temporal bone is primitive in its characters, and seems to indicate a more degraded type than does the skull-cap, a semblance which may be due to sex. The lower jaw is small and akin in character to that of the Bantu or Bushman type. Fragments of limb-bones found in the neighbourhood of the skull-cap are described as human.—A. N. **Henderson**: The elastic arch continuous over several spans, capable only of small rotary motions at the supports.—H. **Bohle**: The heating coefficients of rheostats and the calculation of resistances for currents of short and moderate duration.—J. C. **Beattie**: Further magnetic observations in South Africa during the years 1914–15. The declination, dip, and horizontal intensity are given for twenty-seven stations, including two repeat stations in the Free State, Transvaal, and Cape provinces.—J. C. **Beattie**: True isogonics and isoclinals for South Africa for the epoch July 1, 1913. The results at about 700 stations have been reduced to the epoch from observations at about forty repeat stations fairly distributed over the greater part of the region. The greater number of the observations was made in 1903 and 1909. The westerly declination has decreased in the ten years 1903–13 by about $1\frac{1}{2}^{\circ}$ in the west, and 2° in the east. In the same period the southerly dip has increased by approximately 1° in the east and $1\frac{1}{2}^{\circ}$ in the west.—I. B. Pole **Evans**: Descriptions of some new aloes from the Transvaal.—J. T. **Morrison**: A new harmonic analyser.

BOOKS RECEIVED.

First-year Mathematics for Secondary Schools. By E. R. Breslich. Pp. xxiv+344. (Chicago: University of Chicago Press; London: Cambridge University Press.) 4*s*. net.

The Theory of Valency. By Dr. J. Newton Friend. Second edition. Pp. xiv+192. (London: Longmans and Co.) 5*s*. net.

Relativity and the Electron Theory. By E. Cunningham. Pp. vii+96. (London: Longmans and Co.) 4s. net.

The Telephone and Telephone Exchanges, their Invention and Development. By J. E. Kingsbury. Pp. x+558. (London: Longmans and Co.) 12s. 6d. net.

The Positive Sciences of the Ancient Hindus. By Dr. B. Seal. Pp. viii+295. (London: Longmans and Co.) 12s. 6d. net.

Morphology and Anthropology. By Dr. W. L. H. Duckworth. Second edition. Vol. i. Pp. xiv+304. (Cambridge: At the University Press.) 10s. 6d. net.

New South Wales. Department of Mines. Geological Survey. Mineral Resources. No. 18: The Canbelego, Budgery, and Budgerygar Mines, part ii. of the Cobar Copper and Gold-Field. By E. C. Andrews. Pp. vii+121. (Sydney: W. A. Gullick.)

The Annual of the British School at Athens. No. xx. Session 1913–1914. Pp. iv+182. (London: Macmillan and Co., Ltd.) 21s. net.

Historical Introduction to Chemistry. By Prof. T. M. Lowry. Pp. xv+584. (London: Macmillan and Co., Ltd.) 8s. 6d. net.

Memoirs of the Geological Survey. England and Wales. The Geology of the Country between Whitby and Scarborough. By C. Fox-Strangways and G. Burrow. Second edition. Pp. iv+144. (London: H.M.S.O.; E. Stanford, Ltd.) 2s. 6d.

Diesel Engines for Land and Marine Work. By A. P. Chalkley. Fourth edition. Pp. xvii+368. (London: Constable and Co., Ltd.) 8s. 6d. net.

Apparitions and Thought-Transference. By F. Podmore. New edition. Pp. xviii+467. (London: Walter Scott Publishing Company, Ltd.) 6s.

A Text Book of Elementary Chemistry. By Prof. A. Smith. Pp. x+457. (London: G. Bell and Sons, Ltd.) 5s. net.

A Laboratory Outline of Elementary Chemistry. By Prof. A. Smith. Pp. 152. (London: G. Bell and Sons, Ltd.) 2s. net.

The Metallurgy of Gold. By Sir T. K. Rose. Sixth edition. Pp. xix+601. (London: C. Griffin and Co., Ltd.) 22s. 6d. net.

The Structure of the Fowl. By Dr. O. C. Bradley. Pp. xi+153. (London: A. and C. Black, Ltd.) 3s. 6d. net.

Board of Agriculture and Fisheries. Report of the Agricultural Education Conference: Agricultural Education for Women. Pp. 84. (London: H.M.S.O.; Wyman and Sons, Ltd.) 1s. 3d.

Vigour and Heredity. By J. L. Bonhote. Pp. xi+263. (London: West, Newman and Co.) 10s. 6d. net.

Egypt of the Egyptians. By W. L. Balls. Pp. xvi+266. (London: Sir I. Pitman and Sons, Ltd.) 6s. net.

The "Wellcome" Photographic Exposure Record and Diary, 1916. Pp. 256. (London: Burroughs Wellcome and Co.) 1s.

DIARY OF SOCIETIES.

THURSDAY, DECEMBER 2.

ROYAL SOCIETY, at 4.30.—Note on the Existence of Converging Sequences in certain Oscillating Successions of Functions: W. H. Young.—The Emulsifying Action of Soap; a Contribution to the Theory of Detergent Action: S. A. Shorter and S. Ellingworth.—The Newtonian Constant of Gravitation as affected by Temperature: P. E. Shaw.—Skin Friction of the Wind on the Earth's Surface: G. I. Taylor.

FRIDAY, DECEMBER 3.

GEOLOGISTS' ASSOCIATION, at 7.30.—Some Features of the Antarctic Ice: J. D. Falconer.

MONDAY, DECEMBER 6.

ROYAL SOCIETY OF ARTS, at 4.30.—Optical Glass: Dr. W. Rosenhain.
SOCIETY OF ENGINEERS, at 7.30.—The Modern Development of Water Power: A. Steiger.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—The Use of Graphical Methods in the Solution of Problems in Technical Chemistry: Prof. F. G. Donnan.—The Transport of Material in the Form of Dust: T. C. Cloud.—Sampling and Analysis of Beeswax: M. S. Salamon.

WEDNESDAY, DECEMBER 8.

FARADAY SOCIETY, at 8.—Discussion on "The Corrosion of Metals—Ferrous and Non-ferrous."
ROYAL SOCIETY OF ARTS, at 4.30.—The Art of Finding your Way at Night without a Compass: Lieut.-Col. W. A. Tilney.

THURSDAY, DECEMBER 9.

ROYAL SOCIETY, at 4.30.—Croonian Lecture: The Respiratory Process in Muscle; and the Nature of Muscular Motion: Dr. W. M. Fletcher and Prof F. G. Hopkins.
MATHEMATICAL SOCIETY, at 5.30.—The Vibrations of a Special Type of Dissipative System: H. Jeffreys.—Diffraction by a Wedge: F. J. W. Whipple.—Some Applications of the Two-three Birational Space Transformation: T. L. Wren.
OPTICAL SOCIETY, at 8.—Improvements in Prismatic Compasses, with Special Reference to the Creagh-Osborne Patent Compass: A. Hughes.

FRIDAY, DECEMBER 10.

ROYAL ASTRONOMICAL SOCIETY, at 5.
MALACOLOGICAL SOCIETY, at 7.—Note on the Oligocene of Tampa, Florida, the Panama Canal Zone, and the Antillean Region: Dr. W. H. Dall.—Description of Two New Species of Angasella: G. K. Gude.

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THURSDAY, DECEMBER 9, 1915.

NATIONAL NEEDS.

HIS MAJESTY THE KING, at the opening of the Congress of Applied Chemistry held in London six years ago, made the following notable remark :—

"I fully appreciate the important part which chemistry plays in almost every branch of our modern industry. We all recognise that without a scientific foundation no permanent superstructure can be raised. Does not experience warn us that the rule of thumb is dead, and that the rule of science has taken its place, that to-day we cannot be satisfied with the crude methods which were sufficient for our forefathers, and that those great industries which do not keep abreast of the advance of science must surely and rapidly decline?"

Little heed was given to this warning then or since, and it has needed the most terrible war of any time, in which all the resources of science and the capacity for scientific organisation are brought into action, to awaken the nation partially to a sense of the strength of the forces which natural knowledge provides, either to build up or to destroy. Attention is necessarily concentrated at present upon the mobilisation of science and invention for military and naval purposes, but we must prepare for the unrelenting industrial war which will follow the conflict of arms; and the only sure way of doing this is to put into practice the sound principles to which the King gave utterance in 1909, and which we have persistently urged upon a couple of generations. If the country is not placed in a position to face all competition with confidence, it will be because Ministers of State and manufacturers continue to disregard British genius for original scientific work, and neglect to offer sufficient inducements for its development.

The first thing needful is to change the attitude of the general public towards science from that of indifference to one of intelligent interest, by making all education more scientific. When this has been accomplished, ignorance of scientific methods on the part of municipal and State officials will not be tolerated, and the Ministry of Science, which Sir William Crookes adumbrated in his presidential address to the Royal Society last week, will come within the realm of practical politics. Such a Ministry or Board would secure the organisation of our scientific forces to the national advantage, and would, as Sir William Crookes said, make scientific research "an invaluable profession, with a status of its own at least on a level with that of other learned professions." Our scientific and industrial history shows that we are second to none in capacity for original work and invention, but the State has neglected its duty to organise the powers it thus possesses, and only lately has it done anything to promote co-operation between manufacturers and scientific workers, by the appointment of the Advisory Council on Scientific and Industrial Research.

We have had before us recently several papers and addresses, by men of distinguished eminence, in which reference is made to British and German attitudes towards scientific work, particularly as regards its relation to chemical industries. Dr. C. F. Juritz, in his presidential address to the third general meeting of the South African Association of Analytical Chemists, held on July 9, took as his text the general ignorance which is shown by the State and the great mass of the population of the British Empire as to the work of the chemist. In consequence of this ignorance the remuneration paid to the trained chemist, especially to those occupied in industry, is, on the whole, miserably inadequate; with the result that the best men are driven to apply their talents in other fields of work. It is primarily her appreciation of the value of her scientific workers which has placed Germany in the forefront of modern industry. Britain is suffering in the present war because of her neglect of those very services which Germany has done so much to foster. Science has a right to look for more recognition on the part of Government and a greater scope for her activities; the scientific worker for better prospects of obtaining good remuneration so that he can pursue his work without harassing anxiety as to ways and means. It is owing to the highly specialised character of his work that the chemist has received less public acknowledgment than workers in any other profession, yet chemistry and related sciences lie at the base of most industries.

Dr. L. H. Baekeland, in an interesting address on applied chemistry which appeared in *Science* of October 22, reiterates the statement which has been frequently emphasised in our columns: that a chemist is not a druggist, or even a mere analyser of chemicals, but a scientific man upon whom, if he is adequately trained, the advance of the big scientific industries of the world rests; and, further, that the economic welfare of our

country and the health of its citizens are largely dependent on the way chemical knowledge is used. The present war has done much to give to the chemist his true function in national economics. It has been called "a chemical war" because every department of the fighting armies, from the Red Cross service to the manufacture of guns and explosives, involves chemical knowledge incessantly. It has shown us also some results—direct and indirect—of State neglect to promote the development of scientific industries.

On account of the war, there has been a shortage of artificial dyes and synthetic products in the United States as well as in this country, and steps have been taken in each case to increase the home supply. It may be held, with Dr. Baekeland, that the attention given to these products is out of proportion to their commercial value, which only amounts to 1,800,000*l.* of German imports in the States, whilst the national industries, which include the manufacture of sulphuric acid, the phosphate industry, the manufacture of dynamite, glucose, electrolytic copper refining, production of aluminium, calcium carbide, alkalis, and bleaching powder, are decidedly more imposing in value than the few million imported coal-tar dyes. The national value of an import must not, however, be measured by the purchasing value alone. British industries use annually dyes to the value of nearly 2,250,000*l.*, of which about 1,750,000*l.* have come from Germany, but these dyes constitute an indispensable material in many branches of the textile, leather, paper, and other industries, and the annual value of the goods in which they are an essential or important part is estimated at 200,000,000*l.*

We can be independent of all supplies of synthetic products from abroad if we wish. In industry, science, and invention alike England has led, and can lead, both Germany and the United States. This general thesis was developed by Dr. Dugald Clerk in an inaugural address at the Royal Society of Arts on November 17. Germany with its order and method is compared with "unpractical, illogical, idealistic, laughing England"; and it is claimed, following Buckle, that we are successful because the English brain is inductive, while the German brain is deductive. Dr. Clerk shows that we have abundant reason to be proud of our national achievements; and even if the case for British ability is over-stated, it is a refreshing contrast to the reverse side of the picture often presented; the truth should probably be sought in some intermediate position.

Germany has produced few men of great eminence as originators—far less than Britain or France—but she has a very large number of men of more than average capacity; and, above all, Germany alone has discovered how to make the best use of these by organisation and co-operation. This is the keynote of her success.

Various explanations have been given from time to time to account for the present unsatisfactory position of certain of our chemical industries, such, for example, as the discouraging patent laws, the duty on alcohol, the difficulty of financing improved processes, and the lack of research chemists. Actually the root of the mischief, as Sir James Dewar emphasised in his address to the British Association in 1902, is in the want of education primarily among our so-called educated classes, and secondarily among the workmen on whom these depend. The commanding advantage of Germany is in the abundance of men of ordinary plodding ability, thoroughly trained and methodically directed. It is a fortunate thing for a country to produce inventors, but it profits little if the invention is first converted into a paying proposition by the methodical organisation of the workers in another land! More than one recent statement testifies to the fact that this has actually happened. Proud as we are of our British inventors, it is time that it was realised that we as a nation are losing the faculty of going into the works and applying the invention under the stern conditions of commercial competition.

The advantage gained by the German population owing to the position it has reached in point of general training and specialised equipment will be difficult to overcome. Our great national asset is the power of dogged determination, which never acknowledges defeat. This, coupled with the readiness to accept responsibility, and to take initiative, which characterise so many of the younger men of our upper classes, has led to the establishment of our great Empire. If it is possible to combine scientific knowledge with these national attributes so as to produce and organise the constructively trained mind, the future can be faced with confidence. The difficulties are great, particularly by the opposition of vested interests, the inordinate amount of attention given to sport and pleasure by all classes, and a natural conservatism fostered by neglect of science in education; but the reward is greater still.

THE CHLORINE INDUSTRY.

Manuals of Chemical Technology: iv., Chlorine and Chlorine Products. By Dr. G. Martin. Pp. viii + 100. (London: Crosby Lockwood and Son, 1915.) Price 7*s.* 6*d.* net.

IN the book before us, the fourth of a series of manuals of chemical technology which are being published under the direction of Dr. Geoffrey Martin, the editor gives a concise account of the present condition of the chlorine industry, and of the applications of this substance to the manufacture of bleaching powder, hypochlorites, chlorates, perchlorates, etc., and of its use as a chlorinating agent; with short sections on the manufacture and industrial uses of bromine, iodine, hydrochloric and hydrofluoric acids; and, by way of appendix, a chapter of some half-dozen pages, by Mr. G. W. Clough, on recent oxidising agents—of no very direct connection with the main subject-matter of the book.

It is scarcely to be expected, in a book of 100 octavo openly printed pages, with much of the space occupied by illustrations, that more than the very slightest and most superficial treatment is possible, wholly incommensurable, it must be admitted, with the enormous commercial importance of the subject. At the same time, the little work contains a considerable amount of information, and as an *aperçu* of the contemporary state of the relations of the halogens to chemical industry, it is interesting, and not without value to the student who desires only a general acquaintance with the trend of recent developments in chemical technology. For fuller information the reader is referred to special or larger treatises, the titles of which are given as headings to the several chapters. Indeed, the bibliographies and patent lists, as in the case of the other members of the series, are among the most commendable features of the book. It must be stated, however, that a considerable number of these references are to German sources, altogether inaccessible to the ordinary reader, or even to the majority of those specially interested in the subjects.

During recent years a radical change has come over the manufacture of chlorine, and in all probability at least one of the processes which have originated in this country, and which in its day effected nothing less than a revolution in the alkali trade, is doomed ultimately to extinction. The Weldon process, which at its inception may be said to have saved the position of the Leblanc soda industry, at one time threatened by the rapid development of the ammonia-soda process, has now reached apparently its full extension, and makes no further progress. On the other hand, the competing process of Deacon and Hurter, thanks to the mechanical improvements introduced by Hasenclever and to the elaborate investigations of Haber, Lunge and Marmier, Vogel von Falckenstein and others, on the thermodynamical problems involved, and on the specific action of various "contact agents," still holds its own, and is stated to be even advancing, in spite of many technical difficulties only to be overcome by skill and intelligent management. But it may be doubted whether even this process will ultimately survive the competition of electrolytic chlorine.

The application of electrolytic methods to chemical manufacture has received great development in America and in Germany, but, although there are a few notable exceptions, there has been no corresponding activity on the part of our chemical manufacturers, and the subject scarcely receives the attention it deserves in our technical schools and colleges. The Imperial College of Science and Technology, we believe, made a belated attempt to establish a course of instruction on industrial electrolytic methods—a matter of the greatest importance to the future of our chemical industries, but apparently it was in advance of any public recognition of its vital necessity. Some idea of the growing importance of electrolytic chlorine may be gleaned from the fact that, before the war, Germany produced nearly seven-tenths of the amount she needed by this process. All the important methods of manufacturing electrolytic chlorine and alkali of which published accounts are available are mentioned, and shortly described, in Dr. Martin's monograph, with explanatory diagrams, together with a statement of what is known respecting their current and energy efficiencies.

The manufacture of liquid chlorine has a special interest at the present time, and, as is now well known, large quantities of this substance are made in Germany by the Griesheim process, and, to some extent, in England by the Castner-Kellner method. Owing to the circumstance that dry chlorine does not attack iron, the liquefied gas can be transported in large boilers or steel cylinders. Apart from its use in warfare, it finds extensive application in the manufacture of monochloroacetic acid in the synthetical indigo industry, and as a chlorinating agent in the production of chloroform, chloral, and other organic substances. The account by Dr. Martin of the process of liquefaction gives only a partial and imperfect account of the methods actually employed. Even more bald is the description of the methods of manufacture of the alkali chlorates and perchlorates. Apart from the bibliography, it is scarcely fuller than would be given by an intelligent and reasonably well-

informed student in answer to an examination question. Of more importance is the chapter on bleaching powder and hypochlorites, and the description of recent methods of electrolytic bleaching is of special value. There can be no question that these methods are destined to effect a fundamental change in our textile industries. Already they have displaced a considerable amount of bleaching powder, and their application is rapidly extending, especially on the Continent, where the plants of Schuckert, Kellner, and Oettel are largely employed.

The chapters on the manufacture of hydrochloric acid, bromine, and iodine present no special features of novelty. Until the outbreak of the war practically the whole of the European supply of bromine came from the Stassfurt deposits, but large quantities are now finding their way into commerce from America. The mineral springs of Ohio contain nearly four times the amount of magnesium bromide that is present in the mother liquors obtained from carnallite. The account of the iodine industry is mainly abstracted from Prof. Henderson's article on that subject in Thorpe's "Dictionary of Applied Chemistry." The short chapter on hydrofluoric acid is of interest as showing the increasing commercial importance of this substance, not only in etching glass, but in the purification of graphite from silica, in dyeing, and in the spirit and brewing industries.

The final chapter on peroxides and peracids gives a short description of the more technically important peroxides of the alkalis and alkaline earths, which come into commerce as "oxone," "oxylith," etc., and the various perhydrols, including hydrogen peroxide. The account of the peracids and their salts deals with the so-called persulphuric acid and permonosulphuric acid (Caro's acid) and the persulphates of the alkalis; sodium perborate (used in certain "dry" soaps and as a washing and bleaching agent); and the alkaline percarbonates. These substances have at present only a slight technical importance, but their use is gradually extending.

OIL SEEDS AND THEIR PRODUCTS.

The War and New British Industries. Imperial Institute Monographs. Oil Seeds and Feeding Cakes, with a Preface by Dr. W. R. Dunstan. Pp. xxiii+112. (London: John Murray, 1915.) Price 2s. 6d. net.

IF the war has no other results, it is at least compelling us to examine our affairs in such detail as we have never before attempted, and the examination has brought to light all sorts of curious facts about industries that we ought to have started and did not, and products that we ought to have made for ourselves but purchased instead. Who, for example, would have supposed that the palm-kernel oil used in this country, and grown in British West Africa, had to be pressed out in Germany? It is not to be imagined that the British mills were unequal to the task; but somehow they did not do it, and consequently the outbreak of war threatened West Africa rather seriously. Fortunately, Sir Owen Philipps, the chairman of the West African Section of the London Chamber of Commerce, took the matter up, and equally fortunately the Imperial Institute energetically turned its attention to the whole problem of oil seeds affected by the war. The Institute has already published some important reports on the subject, which are now embodied in the book under review.

The substances dealt with are copra, palm kernels, ground nuts, sesame seed, and mowra seed. All these are produced largely in the British Empire; most of them were sent in great quantities to Germany and Austria, where the oil was expressed, the residues made into feeding cakes for stock (except in the case of sesame and mowra seed), and both these commodities were re-exported to the countries needing them.

The fact only wants stating to compel attention, and Prof. Dunstan has wisely contented himself with a recital of economic uses of the oils and residues, the amounts available, the markets to which the seeds have hitherto gone, and the possibilities of extending the industry. No more eloquent testimony could possibly be adduced to prove the need for establishing this industry in our own country at the earliest opportunity.

The utilisation of oil seeds presupposes two distinct conditions. There must be a demand for the oil, and it must be possible to utilise the residual "cake" left after the extraction. Usually the oil finds application without difficulty. The higher qualities are used for margarine, vegetable butter, olive-oil substitutes, etc.; lower grades for soap-making, lubricating, and illuminating purposes. The residual cake presents a more difficult problem. On the Continent, the copra, palm-nut, and ground-nut cakes are used as cattle food, while the sesame and mowra are unsuitable, and have to find other applications; but in this country the farmer is so well satisfied with linseed and cotton-seed cakes that he sees no reason why he should take up any others. It is here that the crux of the situation lies; the farmer cannot be expected to purchase a product solely for the convenience of the oil mills, nor is it any use trying to badger him into doing so by sending him

pamphlets about food values. The new products must undersell the old ones, and then they will soon begin to find buyers.

Prof. Dunstan and his staff are to be congratulated on the bold way in which they have grappled with the problem and the lucid statement they have drawn up. Already they see some results of their labour; shipments of seeds are beginning to go to Hull to be pressed, and the residues (which alone present any difficulty) have been put under investigation at the various agricultural colleges. Only gross mismanagement can prevent the development of the new industry—unless after the war the Germans again subsidise their own industry so as to extinguish ours, as it is said they did on an earlier occasion when attempts were made to work up the seeds in this country.

E. J. R.

PUBLIC HEALTH ADMINISTRATION.

A Manual for Health Officers. By J. S. MacNutt. Pp. x+650. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1915.) Price 12*s*. 6*d*. net.

IN this country there are numerous manuals of public health, detailing the duties of medical officers of health and other sanitary officers. In the United States we believe the volume here noticed is the first to review public health administration from a practical viewpoint. Part i. is concerned with the organisation and powers of health authorities, part ii. with public health administration.

In a community consisting of separate States, each possessing home rule in sanitary matters, there is evidently much scope for differing regulations. Such differences exist, and we should have liked a fuller statement of the types of legislation and administration than is given in this manual. The information given is, however, clearly set out, and the reader wishing for guidance will find in this book much information in regard to the various classes of service—inspection service, medical service, public health nurse, laboratory service, veterinary service, labour, legal counsel and service.

State organisation is vested in a board or in a commissioner, more often in a board. In Massachusetts this consists of seven persons appointed by the governor, with the advice and consent of his council, for a term of seven years. In New York State, on the other hand, power is vested in a commissioner of health, assisted by an advisory council consisting of two laymen, one sanitary engineer, and three physicians. In both arrangements, democratic control in this reputedly democratic country is indirect and remote, and the medical professions exert a predominant influence. As time passes and experience becomes riper, it will be interesting to compare American city experience with English city experience in sanitary matters. In the latter, as is well known, the electors can more directly and more swiftly influence and alter the constitution of the sanitary authority; and although this sometimes means selfish obstruction to sanitary progress, it necessitates progressive public education in local sanitary administration, and there is seldom serious relapse in progress made. Nor is "graft" so conspicuous in English as in some American cities.

It is remarkable that the States have only in an embryonic stage any central and national health organisation corresponding with that of the English Local Government Board. There is much agitation on this subject; and although the statement sometimes made that "Uncle Sam" spends millions on the health of hogs and little or nothing to promote the health of human beings is exaggerated, it contains a modicum of truth.

The gaps in official administration are much more largely filled up by voluntary associations in America than in this country; and anyone wishing to study the problems of charity, of tuberculosis, of housing, and of child welfare, would need to go largely to these societies for information and for insight into some of the best American work.

Excellent sections of this book are concerned with exploding the sanitary fallacies surviving from an earlier period. The sanitary significance of dirt is stated with discrimination. The limited *rôle* of sewer gas and foul odours is defined; and the error of supposing that running water will more quickly purify itself from pathogenic germs than stagnant water is shown.

Each communicable disease is dealt with in turn, and the succinct advice given is sound and reasonable. The following statement from the section on tuberculosis is the basis on which modern administrative control over this disease is founded. "Experience shows that the normal human system is capable of resisting small doses of infection when it would succumb to a heavier dose, and it is just these heavier doses which supervision over the germ-shedding patient prevents."

In regard to small-pox, it is urged that a hospital for this disease "may be a special department of a regular contagious disease hospital, and, if properly conducted, need not be located at a distance from other habitations. . . . Certainly air infection out of doors is practically nil." This is in direct contradiction to the rigid rule of the

English Local Government Board, which insists on a quarter-mile distance from even a small group of houses.

We have not left space for discussing the chapters on child hygiene, on milk and other food supplies, water supplies, housing, nuisances, sanitary law, and vital statistics; but in each of these the English sanitarian will find useful points for comparison with our own methods. The last chapter deals with publicity; and here is, perhaps, the most characteristic feature of public health work in the States. In relation to the Press, exhibitions, lectures, motion pictures, etc., useful hints are given for bringing home the lessons of sanitation to the general public.

OUR BOOKSHELF.

North America during the Eighteenth Century: A Geographical History. By T. Crockett and B. C. Wallis. Pp. vi+116. (Cambridge: At the University Press, 1915.) Price 3*s.* net.

THE authors have collaborated in an interesting experiment, and have wisely chosen for their first essay (for we presume it is a prelude to others) a region in which the facts of history are easily correlated with those of geography. In one sense it is only another account of the rise of the United States of America, but in a different sense it is a new story, for it tells the history of a century in the light of the place where it occurred. One can imagine oneself in America and watch the drama unfold. We are glad to see that the authors invert the old term and speak of a geographical history, for not only should geography precede history in course of study, but the term historical geography has fallen on evil days so far as school books are concerned. In most cases, except for a preliminary chapter and a map or two, it has no relation to geography.

This book begins with the usual preliminary chapter, but the succeeding ones are not disappointing. The influence of routes and relief, and the question of place relations, are kept to the fore throughout, and very useful are the terse summaries at the end of each chapter. There are many useful black and white maps. In the way of criticism we could wish that the first two maps were a little clearer, and that the authors had curtailed the length of some of their sentences. But we welcome the volume as a most illuminating book. R. N. R. B.

First Aid in the Laboratory and Workshop. By A. A. Eldridge and Dr. H. V. A. Briscoe. Pp. 32. (London: Edward Arnold, 1915.) Price 1*s.* net.

THE authors of this little book, who have been in charge of first aid organisation in chemical and physical laboratories, have found that the ordinary text-books devote too much space to serious fractures and other injuries, but give little information regarding ordinary accidents, such as are apt to occur in laboratories and workshops, for instance, burns produced by chemicals, eye injuries, shocks produced by electric currents, and poisoning. They have therefore written this pamphlet to meet this need. It is prefaced by a commendatory foreword from Sir Alfred Keogh, and we heartily endorse his praise. The directions are terse, clear, and correct.

Determinative Mineralogy: With Tables for the Determination of Minerals by Means of their Chemical and Physical Characters. By Prof. J. Volney Lewis. Second edition. Pp. vii+155. (London: Chapman and Hall, Ltd., 1915.) Price 6*s.* 6*d.* net.

THE present edition differs from the first—reviewed in our issue for January 15, 1914 (vol. xcii., p. 550)—chiefly in the restatement with each table of the classificatory characters and tests leading up to it. The supplementary tables at the end have been extended to include specific gravity and chemical composition; and many more delicate tests have been introduced in both the text and the tables.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Principle of Similitude.

(1) IN his article under the above heading (NATURE, March 18, 1915, p. 66) Lord Rayleigh deduces, by the method of dimensions, an equation for the rate of heat transfer between a solid body and a stream of fluid in which it is immersed. Commenting on this equation, M. Riabouchinsky (NATURE, July 29, p. 591) remarks that heat, temperature, length, and time are treated in the deduction as independent units; and that if we suppose only three of these units to be "really independent" we obtain a different and less definite result.

In a further note (NATURE, August 12, p. 644) Lord Rayleigh acknowledges the interest of the question suggested by M. Riabouchinsky, and indicates the direction in which the solution of the apparent difficulty is to be sought. But since he does not pursue the subject further and the reader may feel as if left in mid-air, it seems worth while that the point raised by M. Riabouchinsky should be somewhat further elucidated.

(2) The question whether any real doubt has been thrown on the validity of Lord Rayleigh's equation hinges on the answer to the question whether temperature can be derived from energy, length, and time, *i.e.* from mass, length, and time.

What do we mean when we say that a given kind of physical magnitude can be "derived" from certain other kinds which we call fundamental? We mean simply that experience has shown that if we use, or combine, certain particular magnitudes of the fundamental kinds in a prescribed way, we thereby determine a magnitude of the derived kind, the size of this resulting derived magnitude being dependent only on the sizes of the particular fundamental magnitudes with which we started, when once the method of using them has been specified. For example, we know that if we construct a rectangle of altitude l on a base l

we thereby determine an area, and we express this shortly by saying: "Area is derived from length." This is all we mean by the conventional term "derivation," and in stating the dimensions of a derived quantity we do not make use of any hypotheses.

Now there is no known process by which, having available only standards of mass, length, and time, we can fix and reproduce any temperature such as the ice point. To do that we require something more—for instance, that the mass shall be a mass of some particular substance having other properties than mere inertia, some one of which may serve as a fourth standard. There is no uncertainty in answering the question referred to at the beginning of this section; whatever Maxwell's demons might do, *we* cannot derive temperature from any three purely mechanical magnitudes. There can therefore be no doubt of the validity of Lord Rayleigh's deduction.

(3) Though the question suggested by M. Riabouchinsky's note is thus answered immediately by an appeal to facts, it may not be amiss to add a few words for those who have fallen into the habit of setting proportionality constants equal to unity and then forgetting all about them.

If we accept the molecular theory, the information it affords on the subject now in hand is that the numerical value of any temperature, on Kelvin's scale, is proportional to the mean molecular kinetic energy of an ideal gas which is at that temperature. We may describe this relation by writing $\theta/\theta_0=T/T_0$, in which T and T_0 are the molecular kinetic energies at the temperatures θ and θ_0 respectively. Both members are pure ratios, and it is obvious that the equation does not furnish any dimensional relation between θ and T; and yet this equation embodies *all* the knowledge which the molecular theory affords on the matter under discussion. To say that the molecular theory authorises us to "define" temperature as the mean kinetic energy of the molecules, would be quite on a par with saying that a peach may be defined as a shilling because the number of peaches we can buy is proportional to the number of shillings we spend upon them, and, in some states of the market, not only proportional but equal. On our ordinary scale, an interval of time is proportional to the angle through which the earth rotates during that interval; but no one thinks of saying that we may define time as angle, or of assigning to time the dimensions of angle. Proportionality of numerical values does not imply qualitative identity.

As Lord Rayleigh remarks:—"It would indeed be a paradox if the further knowledge of the nature of heat afforded by molecular theory put us in a worse position than before in dealing with a particular problem." In reality, the worse position in which M. Riabouchinsky suggests that we place ourselves, would be due not to utilising further knowledge but to ignoring what we already have.

(4) Cases do occur, though the foregoing is not one of them, in which it seems doubtful, at first sight, how many independent units we ought to use. Such a doubt may arise when we ask ourselves if we ought not to use the law of gravitation to eliminate one of our three mechanical units, or the constancy of the speed of light to derive time from length. The discussion of this subject, which involves the question how we are to interpret "universal constants," must be postponed to a future occasion, but the following hint may be given of the conclusion to which such a discussion will lead.

Suppose that we have n independent simultaneous equations, involving $n+k$ quantities, and that we reduce them to a single equation. Each equation represents a single known fact, and when a given equation has been used once, there is nothing further to be gained by using it again; for only a formal and not a real change in the result can be thus produced. If one of the quantities is known to be constant, it may be removed from the list of variables before starting the reduction. But as regards the final result, it is immaterial whether the constancy of a particular quantity is recognised explicitly at the start or not until the end; the conclusion to be drawn regarding the quantities which do vary is the same in either case.

If, for example, the phenomenon under consideration involves the operation of the law of gravitation, as in Lord Rayleigh's problem of the vibration of liquid globe (NATURE, March 18), one of the facts of the problem is expressed by the equation $f=\gamma mm'/r^2$. We may treat the gravitation constant γ as one of the physical quantities involved in the problem, and use this equation to find its dimensions $[\gamma]=[m^{-1}l^3t^{-2}]$; or we may treat γ as a pure number and use the equation to eliminate one fundamental unit by setting $[m^{-1}l^3t^{-2}]=[1]$; but we cannot do both. The final result is in either case that given by Lord Rayleigh.

E. BUCKINGHAM.

Washington, November 23.

Grime's Graves Flint Mines.

PREHISTORIC archæologists will be grateful for the excellent account given in NATURE of November 18 of the report recently published by the Prehistoric Society of East Anglia on the excavations conducted in 1914 at Grime's Graves, Norfolk. It is evident that your reviewer regards the flint implements found at this site as referable to the Neolithic period, and while this view may possibly be correct, the present writer is of the opinion that a close and dispassionate study of the specimens recovered, and of the exhaustive report prepared by Mr. Reginald A. Smith, will not tend to foster any feeling of certainty on this point.

The question of the age of the flint implements found at Grime's Graves is of great importance, and can only be fully and adequately dealt with by experts in prehistoric archæology. The contributor of the article in NATURE is evidently a geologist, and I venture to enter a protest against his taking an authoritative part in the discussion on a technical subject altogether outside the realm of geology. Unfortunately, it does not seem to be generally recognised that the study of flint implements is of a highly complex and difficult nature, requiring as much, if not more, detailed knowledge than is required in many other sciences. The geologist would object, and rightly so, to a prehistorian giving an authoritative opinion upon a question of geology; the archæologist simply asks for a like immunity from inexpert criticism of his particular subject. Your reviewer has every right to give an opinion on the geological problems presented by the excavations at Grime's Graves, and there can be little doubt but that his opinions must carry weight. But the flint implements present a problem that can only be discussed with any profit by experts in prehistoric archæology.

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I inferred from the report of the "experts in prehistoric archæology," that if the various flint implements met with at Grime's Graves had been found separately in different localities, they would have been referred "authoritatively" to several successive periods of human culture. To aid them in dealing with this strange admixture of supposedly distinct industries, I merely pointed out that the geological evidence, so far as discovered, is perfectly harmonious and conclusive, showing that the deposits cannot be older than the Neolithic period.

A. S. W.

DISCOVERY OF A SKELETON OF ELEPHAS ANTIQUUS AT UPNOR, NEAR CHATHAM.

THREE or four years ago a party of Royal Engineers was digging a trench on the banks of the Medway at Upnor, opposite Chatham Dockyard. In the course of their work they came across a number of large bones, some of which were destroyed together with a tusk of great size; at this point they suspended operations. Some time later Mr. S. Turner, of Luton, was collecting flint implements in the neighbourhood and picked up some pieces of bone, which he sent to the Natural History Museum for identification. One of these pieces was recognised as being a carpal bone of a large elephant, and in the autumn of 1913 it was decided to examine the spot in the hope that further remains would be found. From this examination it became clear that a considerable portion, at least, of the skeleton of a very large elephant still remained buried in the clay, and a few bones, including an enormous axis vertebra, were collected. The weather then becoming very wet, operations were discontinued and, for various reasons, not resumed till the past summer. Then, after arrangements had been made with the military authorities, the work of excavation was renewed, and was carried on until there was no hope of further discoveries.

FIG. 1.—Section at Upnor showing chalk below with Thanet sands above; the alluvium in which the bones occur was depo-ited against these. The actual spot where the skeleton was found is at the far end of the section.

The bones were in an extremely fragile condition, and in many cases were so near the surface that they were perforated by the roots of the vegetation growing above them and by worm-burrows. The method of extraction is shown in Fig. 2. The upper surface and edges were first exposed and then completely covered with a series of strips of coarse canvas dipped in plaster of Paris; next the specimens were undercut and turned over, when the encasing process was completed. This work was skilfully carried out by Mr. L. E. Parsons, jun., and thus a large part of the skeleton was safely removed.

The chief portions collected are a tusk about 8 ft. long, portions of the skull and mandible (very imperfect) with one lower and two upper molars in very good condition, numerous vertebræ, and sufficient limb bones of one side or the other to render it possible to restore the fore- and hind-legs almost completely. The teeth indicate that the animal is *Elephas antiquus*, and the discovery is of especial importance because this is the first instance, in this country, at least, in which teeth and a great part of the skeleton have been found in association. Hitherto there has always been uncertainty as to whether bones found were certainly those of *E. antiquus* or not; now it will be possible to give a nearly complete account of the osteological characters of that species.

FIG. 2.—Showing an os innominatum and a femur in process of extraction.

The limb bones indicate that the animal was of enormous size, comparison with bones of an

African elephant of known height showing that it probably stood 15 ft. at the highest part of the back. Thus the humerus is 4 ft. 4 in. in length, while the humerus of an African elephant said to have been 11 ft. 4 in. high is a foot less. The beds in which the bones were found consist of a series of sandy clays and tough clay with numerous flints, much race and ironstone. These were deposited against the side of a slope composed of chalk below and Thanet sands above (Fig. 1). Their exact age is doubtful, but probably they are nearly contemporary with the bone-bearing beds of Grays or perhaps earlier. The molar teeth seem to have belonged to an early form of *Elephas antiquus*, and closely similar to some discovered at Mosbach.

During the excavation the military authorities gave every possible assistance, and without their help the work would have been much more difficult, if not impossible. The specimen has been presented to the British Museum by the War Department. The bones are now being freed from their wrappings and hardened, but it will be some time before they will be ready for exhibition.

CHAS. W. ANDREWS.

BACTERISED PEAT AS A FERTILISER.[1]

THE horticultural world has been interested for some years in Prof. Bottomley's attempt to prepare a new fertiliser from peat. The reasons for that interest are manifest: farmyard manure is constantly increasing in price and decreasing in amount; and artificial fertilisers, excellent auxiliaries though they be, cannot impart to the soil those physical properties without which plants do not thrive.

The market grower, accustomed to raise heavy crops on land treated with enormous dressings of manure—100 tons or more to the acre—is only too anxious to discover other and less costly means of enriching his soil; and even the general public—if we may judge from the attention which is being bestowed in the daily Press on Prof. Bottomley's discoveries—is alive to the importance of increasing the fertility of the land. Hence the spirit of the soil manifests itself opportunely in conjunction with the spirit of the times. It purports to reveal the mystery of the mode of action of bacterised peat—the fertiliser which Prof. Bottomley prepares from peat-moss litter and from certain kinds of raw peat.

Mr. Knox, the author of this volume, has done his work well. He tells his story graphically yet simply, although in chapter ix., entitled "Elementary Conceptions of Chemistry, etc.," he showers a rain of atomic bombs on the reader with such effect that that much-enduring person will doubtless seek cover in the next chapter.

Briefly, this is the story that Mr. Knox has to tell. Certain aerobic bacteria possess the power of liberating from peat large quantities of soluble humates. These soluble humates are in themselves of service to plants as sources of food. They serve, moreover, as a culture-medium in which nitrogen-fixing bacteria—azobacter chroococcum, etc.—multiply rapidly. Hence by adding cultures of nitrogen-fixers to sterilised humated peat, the amount of nitrogen in the latter is increased.

It was to this large nitrogen content that Prof. Bottomley originally attributed the fertilising powers of bacterised peat. Tests carried out at Kew on many different kinds of greenhouse plants—lilies (see Fig. 1), cyclamen, coleus (see Fig. 2), primulas, etc.—indicate in most striking manner that the addition of bacterised peat to a potting compost brings about a great increase of growth and vigour. The amount of bacterised peat (or humogen, as it is sometimes and somewhat inconsequently called) which produces these results is about 10 per cent. of the total compost.

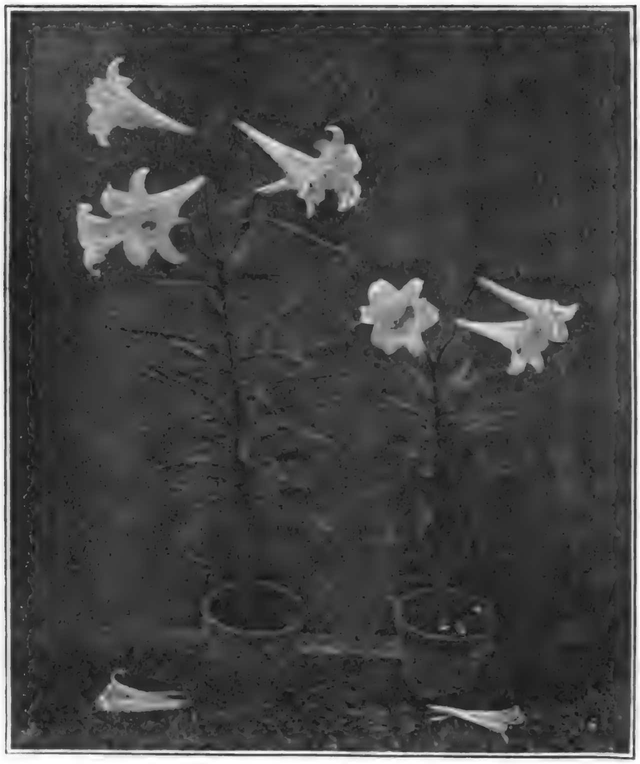

FIG. 1.—The left of the two lilies shown in the illustration was grown in humogen and ordinary soil, while that on the right was grown in a complete food compost. The average number of blooms on the batch (48 size pots) was six as against four, and it should be noted that this is the common effect of humogen treatment on bulbs. (The Royal Gardens, Kew). From "The Spirit of the Soil."

Anyone who takes the trouble to reckon what 10 per cent. means in tons per acre will recognise that, unless far smaller dressings of bacterised peat may be used, this fertiliser cannot be applied with success to field crops; and indeed, in certain field experiments which we have witnessed the addition of dressings of bacterised peat at the rate

[1] "The Spirit of the Soil." By G. D. Knox. Pp. xiii+242. (London: Constable and Co., Ltd., 1915.) Price 2s. 6d. net.

of two tons to the acre produced no beneficial results.

Pot plants treated with bacterised peat show, as compared with controls, not only increased growth but sturdier habit and greater root-development. This fact led to the suggestion that the phenomena cannot be attributed solely to the nitrogen-content of the fertiliser. It is, for example, a well-known fact that the addition of phosphorus-containing fertilisers brings about the development of a more vigorous root-system than is produced in soil poor in available phosphates.

Following up the suggestion that the virtues of bacterised peat are to be sought elsewhere than in the nitrogen contained in the fertiliser, Prof. Bottomley was led to the very interesting conclusion that the growth of plants is conditioned not only by the well-known substance-producing food materials, but also by hitherto unknown growth stimulators. These substances, which he claims to have isolated from peat, Prof. Bottomley has called auximones. He believes that they play a part in plant-nutrition somewhat similar to that played by accessory food bodies in the nutrition of animals.

Like Prospero, who at first called up the wrong kind of spirit, but succeeded on a second attempt, Prof. Bottomley's wand first evoked nitrogen, but now waives that heavy apparition in favour of a more delicate, Ariel-like auximone. Auximones are "it," in the vulgar parlance of the day, or in the more elegant language of Mr. Knox they are the spirit of the soil.

Prof. Bottomley brings forward evidence in favour of the existence of auximones and of the important part they play in activating the growth of plants. It is, however, in no hyper-critical spirit that we confess that the evidence does not appear to us strong enough to bear its burden. Biologists need no reminder of the pitfalls that beset their attempts to establish hypotheses by the method of comparison. Although often the only method at our service, it is a very clumsy one; and in a subject of such importance as the existence of a new type of food substances, the evidence must be overwhelmingly strong before the hypothesis which it supports may be accepted.

We do not think that Prof. Bottomley's evidence is strong enough to support this test. Nevertheless, it should not be dismissed lightly; rather is it a case like so many in biological science, in which a just judge would order a fresh trial. We understand that such a trial is to be conducted at Rothamsted, and we hope, for the sake of horticulture and agriculture, that it may lead on one hand to the demonstration of the fertilising value of bacterised peat, and on the other to the just judgment of the case for auximones.

FREDERICK KEEBLE.

FIG. 2.—Two specimens of coleus grown at the Royal Gardens, Kew. The right-hand plant received humogen, while the left had the usual potting compost. From "The Spirit of the Soil."

DYSENTERY AND WAR.

DYSENTERY is a term embracing several varieties of intestinal flux. Anatomically there is inflammation, and frequently ulceration of the large bowel. Owing to improved sanitary conditions the diseases described under dysentery have become infrequent in this country, though outbreaks occasionally occur, particularly in overcrowded institutions. In the past, however, widespread epidemics have prevailed, notably one which raged between 1847 and 1856; and in the tropics dysentery still deserves its

reputation as being one of the most destructive of diseases.

Dysentery, moreover, is one of the great diseases attacking camps, and has been more destructive to armies than powder and shot (Osler). In the Federal service during the Civil War, according to Woodward, there were 259,071 cases of acute and 28,451 cases of chronic dysentery, and the disease prevailed widely in the South African campaign, in the Franco-German War of 1870, in the Crimean War, and even before the Battle of Agincourt in 1415. In the present campaign, too, dysentery has prevailed both in the Western and Eastern seats of war—in Gallipoli, for example, in the course of a few months some 78,000 men were invalided on account of sickness, a large proportion of whom suffered from this disease.

The two principal types of dysentery are the amœbic and the bacillary, due respectively to an amœbiform protozoon and to a group of closely-allied bacteria, the dysentery bacilli. Amœbic dysentery or "amœbiasis" is essentially a disease of the subtropical and tropical regions of the globe, and is widespread over the continents of Africa, Asia, and America, and is particularly common in Egypt and India. The causative parasite, the *Entamoeba histolytica,* is met with as an organism resembling an ordinary amœba in the mucus passed in the acute stage of the disease, and in the liver abscesses which frequently complicate the disease. In this stage it is actively motile, and has a diameter of 1/1000–1/600 in. It has also an encysted resting stage, found in the intervals between attacks and in latent cases.

Bacillary dysentery, on the other hand, is of world-wide distribution, and is apt to occur in epidemics, thus differing from amœbic dysentery. Ogata first isolated and described a dysentery bacillus in Japan; this was followed by researches by Shiga in the same country in 1898, and by Kruse in Germany. They proved that the bacillus is a specific one, and it was shown later that it was the same bacillus which is now known as the *Bacillus dysenteriae* of Shiga and Kruse. Later other varieties were isolated by Flexner and by Strong in the Philippines, and by Hiss and Russell (the Y-bacillus).

In England at the present time outbreaks of dysentery chiefly affect asylum populations, and these are almost always caused by the *Bacillus dysenteriae* of the Flexner type. In one asylum outbreak in England and in an epidemic in Scotland Shiga's bacillus has been isolated.

Almost all the cases of dysentery returning from Gallipoli are of the bacillary variety, and the experience of Ledingham, Penfold, and Woodcock[1] appears to show that the infection is chiefly with the Shiga bacillus, while in a smaller number the Flexner bacillus is present. From the eastern Mediterranean a few cases of infection with the *Entamoeba histolytica* have been reported. Among the French in the Argonne the large majority of the numerous cases occurring there are due to the Y-bacillus of Hiss and Russell. In the Germany army on the west front cases due to the Flexner bacillus are reported, while among the Austrians infection with the Shiga bacillus is met with.

In the treatment of amœbic dysentery emetine, an alkaloid of ipecacuanha, is practically a specific, and for the bacillary form anti-dysentery serum is very successful.

Outbreaks of dysentery in armies raise many important problems for the sanitarian. The disease is partly water-borne, though, of course, there is considerable opportunity for direct contamination of food and person in camp and trench life. The intestinal evacuations of cases contain vast numbers of dysentery bacilli and, unless disinfected, infect the locality, particularly the trenches and their neighbourhood, where the men are attacked before removal to hospital, while infection may be spread far and wide owing to the fact that the bacillus does not necessarily disappear from the patient with the onset of convalescence, but may remain in the body for a long time after cessation of symptoms, so that the "carrier" state becomes established. It would probably be desirable to regard a case as possibly infective for a period of three months after the termination of the attack, but the exigencies of war may prevent such a course. Bacteriological examination ought also to be carried out so far as possible to determine when an individual has ceased to be a "carrier."

At present a high standard of general and personal hygiene is the best preventive of the disease. Attempts have been made to introduce preventive inoculation against bacillary dysentery, but with what success is not yet known.

R. T. HEWLETT.

OILS AND FATS AS WAR SUPPLIES.

THE discussion in the House of Commons last week, on the export of oils to neutral countries bordering on Germany dealt with a matter on which scientific knowledge might have been brought to bear with great national advantage.

There is no doubt that fats are the one material that a country situated in northern Europe must procure from without; indeed, the price of oils current in Germany affords complete testimony of the accuracy of this statement. Fats are of value for two purposes: first, as an altogether indispensable article of food, and, secondly, as a source of glycerine, which is converted into nitroglycerine and becomes an ingredient of all propellent explosives. Apart from tallow, and perhaps some small amount of linseed, Germany produces no other fat, and her stocks could have lasted but a limited time only. The deficiency has been made up by imports from tropical lands through neutral countries, which, so long as we have control of the seas, can only be obtained by favour of Great Britain.

One by one restrictions have been placed on

[1] See *Brit. Med. Journ.*, November 13, 1915, p. 704.

the export from British ports of the more obvious fatty materials used as food, but the fact that oils contain glycerine seems to have been largely overlooked, though the belated announcement made last July by Sir F. E. Smith, then Solicitor-General, that "it had recently (!) been discovered that glycerine could be made from lard" must not be forgotten. Some oils or oil-yielding materials are still being allowed to go to neutral countries; for example, linseed or linseed oil, and palm kernels, have been exported to Holland; whale oil is being largely shipped to Norway. Linseed oil, which was formerly only of use as a drying oil, can now be saturated with hydrogen and converted into a hard, white fat suitable for use in margarine. The same applies to whale oil; and there is a very large factory in Norway engaged in this work.

It was claimed in the debate that it is necessary to send these oils to Holland in order that cheap margarine may be returned to Britain. If this be so, the question arises whether all that is possible has been done to protect and foster our own margarine industry, and if the English output of margarine is at its maximum. The answer is probably in the negative—the English maker is short of labour and he is being undersold by his foreign rivals, who are making huge profits in the German markets.

PROF. C. R. ZEILLER.

CHARLES RENÉ ZEILLER, whose death after a long illness was announced from Paris a few days ago, was a member of the Institute, chief engineer of mines, and professor of palæobotany in the National School of Mines. Despite the heavy claims of official duties, Zeiller devoted himself to palæobotanical investigation for nearly forty years. His earlier papers dealt with the Carboniferous and Permian plants of France, and the most important of these is the volume, published in 1878, on the plants of the French Coal Measures. The beautifully illustrated and scholarly monographs of Palæozoic floras, including those of Valenciennes, Commentry (in collaboration with the late M. Renault), Autun, Brive, Creusot, and Blanzy, are models of scientific exposition and thorough workmanship. The two volumes on the Rhætic flora of Tonkin, published in 1903, are the most important of his contributions to the botany of the earlier phase of the Mesozoic era. He also wrote several papers on later Mesozoic plants from different parts of the world, and added considerably to our knowledge of the Permo-Carboniferous floras of South Africa, Brazil, and India, both by his description of new types and his masterly treatment of the wider problems presented by the so-called Glossopteris flora of the southern hemisphere.

Though mainly concerned with impressions of Palæozoic and Mesozoic plants, Zeiller's researches into the structure of the Palæozoic fern Psaronius and, more recently, his work on the anatomy of Lepidostrobus bear witness to his skill as a morphologist. For many years he contributed to the *Revue Générale de Botanique* a critical and comprehensive survey of recent palæobotanical literature; the enormous amount of work represented by these articles illustrates his untiring energy and his unselfish devotion to the subject which he loved. In 1905 Zeiller was elected a foreign member of the Linnean Society, and in 1909 he received the same recognition from the Geological Society of London. In the latter year he visited England for the first time to attend the Darwin celebration at Cambridge, and was one of the distinguished band of foreigners upon whom the University conferred honorary degrees.

Zeiller had a remarkably wide and accurate knowledge of his subject. He was much more than a learned systematist; while scrupulously accurate in his exceptionally lucid descriptions, he always took a broad view. He had the power of synthesis as well as that of analysis. He never wrote too much, and all that he did bore testimony to his courtesy, singleness of purpose, and modesty. Zeiller was a man of simple dignity and great personal charm; his death is a severe blow to a department of knowledge which claims a comparatively small number of students. He leaves a rich legacy of scientific achievement to a younger generation, and to his friends the stimulating memory of a noble character.

A. C. SEWARD.

PROF. F. R. BARRELL.

BY the sudden death, on December 2, of Prof. F. R. Barrell, at fifty-five years of age, the University of Bristol has lost one of the senior members of its staff. After graduating at Cambridge (Math. Trip., 1882, 14th wrangler; Nat. Sci. Trip., 1883) and in London University (B.Sc., 1884), he was for two years lecturer in Hammond Electrical College and for five years instructor in natural science in the *Britannia*. In 1890 he was appointed lecturer in mathematics in University College, Bristol, and was given the status of professor in 1893. When the University College was merged in the University of Bristol he was elected Dean of the Faculty of Science, and was one of the representatives of Senate on Council. At the time of his death he was Dean of the Arts Board, and again a member of Council.

Sound, especially in fundamental conceptions, rather than brilliant as a mathematician, his main interests lay in the application of mathematics to practical problems in physics and in methods of teaching, with constant insistence on the importance of a securer basis clearly and adequately grasped. His work bore fruit in its influence on those whom he trained. In his earlier days he wrote on electrical problems ("Electricity and Magnetism," 1894), and later on "Elementary Geometry" (1904). He was a pioneer in the localisation of a needle or bullet by

taking two photographs by X-rays on the same plate. Its position, including its depth, was worked out from the photograph by an elegant geometrical construction. He reduced the method to sufficient simplicity for its general use by surgeons, and it has proved of great value when the bullet is deeply and awkwardly placed. He used this method at Netley, where he served as expert adviser during his last long vacation. His offer to resume his work there during the coming Christmas vacation was accepted in a letter which reached his house shortly after his death.

His sincerity and loyalty, his ever-ready sympathy, and his faithful discharge of the many duties he gladly undertook, endeared him to his colleagues and to many generations of students, who were quick to recognise and to appreciate his worth. A man of strong convictions, and one who had the courage fearlessly to uphold them, he won the admiration even of those who differed from him. Within the University, and far beyond its precincts, he was rich in the friendship which attaches to characters such as his. He leaves a widow, who has shared with him the affection and esteem in which he was held, and two sons, who now hold commissions in the Army.

NOTES.

BY the death of Mr. Henry Eeles Dresser, from heart failure, at Cannes, on November 28, at the age of seventy-seven, ornithology has lost one of its most distinguished students. Attracted to the study of birds from his early boyhood, Mr. Dresser devoted the leisure hours which he could spare from the arduous duties of a city life to the elucidation of the avifauna of the Palæarctic region, and gave up his well-earned holidays to extensive travel in Europe, Asia, and America in prosecution of his favourite study. He made his first contribution to scientific literature in the pages of the *Ibis* in 1865, and for a period of almost fifty years he continued to write on ornithological subjects in that journal and in the Proceedings of the Zoological Society. His most noteworthy contributions to ornithology are, however, his "History of the Birds of Europe," in eight quarto volumes, 1871–81, followed by a supplementary volume in 1895–96; "A Monograph of the Meropidæ," 1884–86; "A Monograph of the Coraciidæ," 1893; "A Manual of Palæarctic Birds," 1902–3; and "The Eggs of the Birds of Europe," in two volumes, 1910. For the purposes of these monographs he gradually acquired a magnificent collection of the skins and eggs of Palæarctic birds, now in the Manchester Museum, each specimen in which is fully authenticated and adequately labelled. The care with which he attended to these matters has rendered his collection one of the most valuable in the country. His work is marked by thoroughness, rigid accuracy of description, and careful attention to detail, while the coloured plates, made mainly from drawings executed by Joseph Wolf and J. C. Keulemans, illustrating his monographs are among the most beautiful and accurate in ornithological literature. Ornithology is indeed the poorer by his death.

WE regret to announce that Dr. Robert Caird, of Messrs. Caird and Co., shipbuilders, Greenock, died suddenly of heart failure on December 1, in his sixty-fourth year. We are indebted to Prof. A. Gray for the following appreciation of his activities in scientific fields:—Dr. Caird was well known as an engineer and naval architect, and for many years had been recognised as one of the leading authorities on marine engineering and the construction of ships. After some time spent in America, at the works of the Pullman Car Company, he joined in 1888 the firm founded by his father (who in his day was a leading Clyde shipbuilder), and, with his brothers, Patrick and Arthur Caird, built nearly all the present vessels of the Peninsular and Oriental Company's fleet, and many other great liners. From 1899 to 1901 Dr. Caird was president of the Institution of Engineers and Shipbuilders in Scotland, and he was also a fellow of the Royal Society of Edinburgh. In 1900 the University of Glasgow conferred on him the honorary degree of doctor of laws for his services to applied science. But it is perhaps not so widely known that Dr. Caird was keenly interested in pure science, especially applied dynamics, and did much in many ways to promote its progress. About thirteen years ago he entered *con amore* into the movement for the better equipment of the University of Glasgow; his firm gave a large subscription to the fund, and Dr. Caird himself took a very special interest in the foundation and equipment of the splendid new Natural Philosophy Institute, which was one of the results of the movement. To every detail of that building he gave the most careful attention, and the Natural Philosophy Department owes much to his practical interest and generosity. He had previously been an active member of the committee of Clyde engineers, to whom the University is indebted for the erection and equipment of the James Watt Engineering Laboratories.

MR. C. J. WOLLASTON, who died recently at ninety-five years of age, was not personally well known among the younger generation of present-day telegraph engineers, for he retired from active work fifteen years ago with a well-merited recognition of his services in the introduction of submarine telegraphy. His name, however, will go down to posterity as that of a member of the small company to which was transferred the concession granted by Louis Napoleon for laying a telegraph line under the English Channel. He was one of the engineers in charge of the operations on the *Goliath*, which started on August 28, 1850, from Dover to lay the line thence to Cape Grisnez, and reached its destination in the evening, from which point messages were exchanged between England and France "under the strait and through it for the first time." The line consisted of a single gutta-percha covered wire 1/10 in. diameter coiled on a drum mounted amidships on the vessel, and weighing five tons. It was paid over a roller at the stern, and sunk to the bottom of the sea by means of leaden clamps. Within three days from being laid the line was destroyed, but the possibility of submarine telegraphy

was established, and a more ambitious and successful attempt was made in the following year. The cable here consisted of gutta-percha covered wires protected by coated hemp yarn, and an outside covering of galvanised iron wire. The weight of this cable was about 200 tons, and the electrical testing was carried out by Mr. Wollaston. This work took place on October 31, 1851, and on November 13 of the following year the cable was opened for public use between England and France.

WE regret to announce the death, on December 3, at forty-seven years of age, of Dr. A. Vaughan, lecturer on geology in the University of Oxford.

THE death is announced at Ranchi, India, of Colonel F. J. Drury, of the Indian Medical Service, Bengal. He was Inspector-General of the Civil Hospitals of Bihar and Orissa, and formerly professor of pathology at the Medical College, Calcutta.

THE death has occurred, in his sixty-eighth year, of Dr. M. A. Veeder, of Lyons, N.Y., who wrote largely on water supply and other questions relating to public health. He also made a study of the relation of pack ice in the great lakes of North America to the Glacial period, and carried out an extensive investigation of electromagnetic phenomena of solar origin, especially with reference to the causation of the aurora.

DR. GEORGE STERNBERG died on November 3, in his seventy-eighth year. He graduated at the College of Physicians and Surgeons, Columbia University, in 1860, entered the United States Army as assistant-surgeon in 1861, and retired with the rank of Brigadier-General in 1902. He served throughout the Civil War, and was in charge of the American Medical Service in the war with Spain in 1898. Dr. Sternberg had a special knowledge of cholera and yellow fever, and the Yellow Fever Commission of 1900 was appointed on his initiative, and practically solved the mode of transference by the mosquito. He founded the U.S. Army Medical School at Washington, and was the author of two large manuals of bacteriology, a treatise on malaria, a book on photomicrography, and a work on immunity, serum therapy, and protective inoculation, as well as many Government reports.

MR. GEORGE SMITH, who died on November 19, at the age of sixty-four, was one of the oldest and most experienced chemists and works managers in the employ of Nobel's Explosives Company, Limited, Glasgow. Born at Woolwich, he went through the School of Mines, and after some experience at the Woolwich Arsenal Laboratory, and at the Stowmarket Works of the New Explosives Company, he entered the services of Nobel's Explosives Company in 1879, as the works manager of their Westquarter Factory in Stirlingshire, where detonators and sulphuric acid were produced. During his capable management the factory grew in size and importance, other manufactures were added, and when Westquarter was no longer able to satisfy the demands placed on it a new factory was built at Linlithgow for powder fuse. Mr. Smith retired from active work in 1913, and lived afterwards at Hastings and St. Leonards. He was a fellow of the Royal Society of Edinburgh and of the Institute of Chemistry, and took out various patents during his active life. His numerous friends will long remember him and mourn his loss.

THE following are among the lecture arrangements at the Royal Institution before Easter:—Prof. H. H. Turner, a course of six illustrated lectures, adapted to a juvenile auditory, on "Wireless Messages from the Stars"; Prof. C. S. Sherrington, six lectures on the physiology of anger and fear, and nerve tone and posture; Dr. E. J. Russell, two lectures on the plant and the soil; Prof. A. Keith, two lectures on sea power as a factor in the evolution of modern races; Prof. F. Keeble, three lectures on modern horticulture; Prof. W. A. Bone, three lectures on utilisation of energy from coal; Sir F. Watson Dyson, Astronomer Royal, on measurement of the brightness of stars; Prof. L. W. King, two lectures on recent excavations in Mesopotamia; Prof. H. E. Armstrong, two lectures on organic chemistry in war; Sir J. J. Thomson, six lectures on radiation from atoms and electrons. The Friday evening meetings will commence on January 21, when Sir James Dewar will deliver a discourse on problems in capillarity. Succeeding discourses will be given by Prof. L. Hill, Prof. W. Bateson, Prof. E. G. Coker, Prof. S. P. Thompson, Sir Napier Shaw, Dr. A. Strahan, Prof. W. M. Bayliss, Prof. A. Fowler, and Sir J. J. Thomson.

THE theory that the possession of territory, and the struggle which this involves, was a factor in sexual selection was first definitely formulated by Mr. H. Eliot Howard, in his remarkable book on "The British Warblers." The soundness of this view is now attested by Mr. J. M. Dewar in his studies on the oyster-catcher in relation to its natural environment. In the *Zoologist* for November he goes still further, and holds that the "law should be extended to apply to the birds in winter, as they then have territories, though no opportunity has come under notice of a territory needing to be defended against intruders." Howard's view that the possession of territories is a biological advantage, both to the individual and to the species, by securing an adequate, and no more than an adequate, supply of food, is borne out by the general evidence derived from the areas under observation in regard to the oyster-catcher.

IN an article entitled "Reactions to the Cessation of Stimuli" (*Psychological Review*, vol. xxii., No. 6), Mr. H. Woodrow describes some experiments which show that the reaction to the cessation of a sound or light stimulus is in all cases the same as the reaction time to the beginning of that stimulus, and that the lengthening in reaction time due to a decrease in intensity of stimulus is equal in amount, and follows the same law, in the case of both beginning and cessation reactions. The author, in attempting to find an adequate hypothesis which shall subsume these facts, criticises both the latent period view and synaptic resistance, and develops his theory of the central nervous system as the seat of a complex system of inter-related activities and potential energies, which is disturbed throughout by any change in any part of the system. The physiological disturbance in this case is in part the process of becoming aware of a stimulus

or of attending to it. A small change in excitation disturbs the pre-existing cortical system so as to bring about the reaction time more slowly than does a large one, not because of the resistance to its conduction, but because of the inertia of the pre-existing central system. Physiologists and psychologists will find the article interesting and controversial.

IN the *Philippine Journal of Science*, vol. x., No. 5, for September, 1915, Mr. E. D. Merrill continues his descriptions of new or noteworthy plants from the Philippines. This instalment, which is No. xii. of the series, includes seven genera credited for the first time to the Archipelago, viz., Avena, Polytoca, Angelesia, Glyptopetalum, Ochrocarpus, Asystasia, and Polytrema. Sixty-two new species are described belonging to various families, and in all eighty species are added to the Philippine flora. The Avena is, no doubt, an introduced plant.

THE cultivation of sisal hemp and its preparation forms the subject of an article in the Bulletin of the Imperial Institute, vol. xiii., No. 3. From Mexico, the home of the plant, it has been widely distributed, and is now being successfully grown in British East Africa and in the Bahamas has long been introduced. The article deals especially with the history of the introduction of the plant into various countries and the preparation of the fibre for market, where its chief use is in the making of twine. It is pointed out that for a successful enterprise large areas must be planted, especially if a factory is to be erected. Details with figures are given of British machinery for the preparation of the fibre.

THE annual report of the Department of Agriculture, Uganda, for the year ending March 31, 1915, is a record of useful and steady progress. An interesting account of coffee cultivation is given, from which it is seen that the coffee-leaf disease (*Hemileia vastatrix*) is on the wane, and does not appear to be seriously affecting the coffee plantations in the country. A chart is given showing the fluctuations in the amount of the disease compared with rainfall and humidity on the Government plantation, Kampala, but the outstanding feature of the chart is that the disease reaches its maximum during the months July to September. Other fungus parasites are dealt with in the report of the Botanist, but there does not appear to be any serious disease affecting the economic products in Uganda.

THE ninety-third Report of the Commissioners of Woods, Forests, and Land Revenues, dated June 29, is mainly concerned with the financial state for the year of the Crown properties under their charge. These are multifarious in kind, including, in addition to land let for buildings, foreshores, mineral rights, etc., 346,935 acres, of which 69,103 acres are under the growth of timber. The main centre of active forestry operations is the Dean Forest and Highmeadow Woods in Gloucestershire, which are about to be used as a forestry demonstration area. The old school for the training of woodmen at Parkend has been extended to include more men under instruction; and a new School for Forest Students is now being erected near Speech House. The wood distillation works, which were opened in October, 1913, have proved successful. Large quantities of charcoal and fuel-wood from the various Crown forests were dispatched to the trenches in Flanders. Increased quantities of pit-wood have been sold from Dean Forest and Tintern Woods. The Crown holds in England 73,375 acres of agricultural estates, consisting mainly of farms varying from 50 to 1000 acres in extent; but 9,374 acres are now let for small holdings and allotments. The greater part of the latter have been created in the past nine years, during which period eighty-seven new cottages and seventy new sets of farm buildings were erected, whilst existing cottages and homesteads were altered and improved.

ACCORDING to the Bulletin of Economic and Social Intelligence issued by the International Institute of Agriculture, the co-operative movement is very successful in Finland, where 10 per cent. of the whole population are members of such societies; this proportion, in fact, is only surpassed by Denmark, where the corresponding figure is 25 per cent. An unusual organisation of the kind is that established for the working of peat moors. The use of peat litter in retaining the most valuable constituents of manure is generally recognised, and since Finland is very rich in peat deposits, their working in the interests of agriculture has developed greatly. The co-operative society buys a moor, or acquires the right of extracting peat, constructs the necessary drying sheds, and then sells the peat to its members. Some of these societies are very large, owning plant to the value of 4000*l.*, and exporting their peat abroad.

A THIRD article on the economic resources of the German colonies, dealing this time with those in West Africa, is published in the new number of the Bulletin of the Imperial Institute. The Cameroons, the chief peak of which rises to 13,000 feet, export rubber, palm kernels, cacao, and palm oil especially, and also to a smaller extent gum arabic, kola, and shea nuts. Some attention has been devoted to the cultivation of tobacco with considerable prospects of success. Stock-breeding, as in other German colonies, has been well developed, despite the difficulties caused by tsetse fly. Much of the territory is unexplored, but so far no minerals of particular economic importance are known. It may be added that so far as the flora is concerned, the region is remarkably interesting. Togoland exports oil palm products, maize, rubber, and cacao, and cotton, copra, ground nuts, and kapok are among the minor articles of export. A good deal of attention has also been paid to forestry, with promising results. Iron ores occur abundantly, and good limestone is also found, but lack of transport facilities has prevented the establishment of any definite iron-ore industry.

THE recently received second number of the fifth volume of the *Journal of Agricultural Research*, published by the Department of Agriculture in Washington, contains two interesting phytopathological papers by Mr. I. E. Melhus. In the first of these it is pointed out that the possession of perennial mycelium, hibernating in the tissues of their respective host-plants, is a characteristic feature of many species of

parasitic fungi belonging to the family Peronosporaceæ, of which perhaps the most widely known is the potato-blight fungus, *Phytophthora infestans*. A list of fifteen species is given in which this hibernation occurs, the necessary evidence being supplied by the author himself for four of them. In the second paper evidence is adduced to show that the source from which the potato-blight originates each season is to be found in aerial shoots of the potato, which become infected with the mycelium of the fungus direct from the diseased tuber. From nearly a thousand diseased tubers specially planted during the seasons of 1913 and 1914 five cases arose where one or more diseased, spore-bearing shoots were produced, and four of them served as centres from which the blight spread to neighbouring, healthy plants. That this might occur was shown by de Bary over half a century ago, but, although confirmed later by Jensen, it cannot be said that this view of the mode of infection of the crop has met with universal acceptance. Mr. Melhus's work, therefore—carried out under field conditions—provides a further and substantial measure of support for the original view propounded by de Bary.

In the annual report of the Smithsonian Institution for 1914, Mr. E. N. Marais has an account of the drought in Watersberg, South Africa. The name was originally given as expressive of the fertility of that part of the Transvaal. To-day it is practically a desert with dried-up watercourses, dead orange groves, and desolate pasture lands. The game, once very plentiful, has almost all left the district, and little animal life remains. Only the numerous thermal springs remain unaffected, and on these the few inhabitants depend for drinking water and for irrigation.

The pastoral and agricultural possibilities of Central Australia have been a good deal discussed in recent years. Attention was directed to them at last year's Australian meeting of the British Association. The probable value of the region to the north-east of Kalgoorlie and Laverton is indicated in a paper by Mr. A. C. Macdonald in the *Victorian Geographical Journal* (vol. xxxi., part ii.). Mr. Macdonald brings together evidence from explorers and others to show that the rainfall, though most irregular, is by no means absent, but that the soil would be most productive under a proper system of irrigation. This, he contends, would be feasible, since artesian water in quantities has been proved to exist near the surface. There is every indication that this water is quite suitable for irrigation, and is not heavily charged with alkali.

The United States Geological Survey is publishing a series of four geographical handbooks for travellers, each book covering one of the chief railway routes west of the Mississippi. The second one deals with the Union Pacific route from Omaha to San Francisco (Bulletin 612, The Overland Route, price 1 dollar). The idea is excellent, and is admirably carried out. Much geographical information otherwise difficult of access is collected, and many historical details are added. The illustrations are good, but the chief feature of the volume is the series of twenty-five contour maps on a scale of 1 to 500,000. They are clear and well printed, and free from crowding of detail, yet contain all that a traveller could desire. Each map is conveniently placed for reference from the text. The book has much value even for those who do not contemplate going the journey.

The Canadian Department of Mines has issued a very interesting monograph (Memoir No. 78) on the Wabana iron ore of Newfoundland, by Mr. A. O. Hayes. These famous iron-ore deposits form a number of beds, which outcrop for about three miles along the northern shore of Bell Island, Conception Bay, and dip to the north-west under the waters of the bay. These beds form part of an extensive series of Ordovician sedimentary deposits, mainly of sandstones and shales, comprising the higher beds of the northern limb of a somewhat flat anticline. The upper 1000 ft. of this series contain a number of ferriferous beds, two of which, known as the "Dominion Bed" and the "Scotia Bed," are of workable thickness, the former averaging about 10 ft. and the latter, the upper one, about 8 ft., though thicknesses up to 30 ft. have been met with. The total quantity of iron ore is estimated at more than 3000 millions of tons. The ores consist mainly of red hæmatite, together with chamosite (aluminous ferrous silicate), and siderite. The ore is oolitic in structure, the spherules consisting generally of alternate concentric layers of the two first-named minerals, though some consist wholly of hæmatite. Fragments of fossil shells occur throughout the ore, and it is to their presence that the phosphoric acid in the ore (usually 1·5 to 2·5 per cent.) is due. The author considers these ores to be primary deposits formed in shallow seas, and holds that "the iron was derived by long-continued weathering of earlier crystalline and sedimentary rocks, the solution of their iron content by mineral and vegetable acids and subsequent transportation of the iron salts by streams into the sea." He holds that the evidence is against the probability of these ores having been formed by the metasomasis of an original oolitic limestone.

The rainfall over the British Isles for October is dealt with in *Symons's Meteorological Magazine* for November, and the rainfall table gives the tentative results of the British Rainfall Organisation prior to the publication of fuller details in the rainfall volume for 1915. There were only three stations in Great Britain with an excess of rain—Rousdon having 190 per cent. of the average, Stroud 121 per cent., and Braemar 103 per cent. Arncliffe, in Yorkshire, had only 21 per cent. of the average rainfall, and was relatively the driest place in the kingdom; Seathwaite had 26 per cent. of the average, and Hull 31 per cent., whilst other places had more than 33 per cent. The greater part of Ireland was wet, but the fall at Omagh was only 82 per cent. of the average, while it was as high as 179 per cent. at Waterford, and 155 per cent. at Gorey, Wexford. Less than one-half of the average rainfall for the month is said to have fallen over the west and north-west of Scotland and over the northern half of England and Wales. The map for the Thames Valley shows a considerable range in the rainfall, the measurement for the month amount-

ing to 7 in. in the south-west, whilst it was less than 2 in. in the north-east and in part of the upper Thames.

IN an address to the American Institute of Electrical Engineers in February last Dr. Rosa, chief physicist at the Bureau of Standards, gave an account of the work done by the bureau, with special reference to the electrical part of the work. The address is reproduced in the November number of the Journal of the Franklin Institute, and from it we learn that a new electrical building, 190 ft. by 60 ft., and five stories high, has just been completed at a cost of 40,000*l.*, and that a similar building is about to be erected for the chemical division. When this is complete the United States Government will have spent 400,000*l.* on the bureau and its equipment. So far as the electrical division is concerned, the work is subdivided into eleven sections as follows:—Resistance and electromotive force; inductance and capacity; commercial measuring instruments; magnetic measurements; photometry; wireless telegraphy; electric railway work; electric lighting and power; safety rules, regulations, and devices; gas supply; telephone service.

MR. C. P. SPARKS, who has succeeded Sir John Snell as president of the Institution of Electrical Engineers, delivered his inaugural address on November 18. He dealt chiefly with the development of the electricity supply industry, and, in the last part of his address, suggested the directions in which further progress might be anticipated. These, he thought, would largely be governed by the necessity for fuel economy, and he put forward the proposition that the economical use of coal had been hindered in this country by its low price. One of the next steps to lower the cost of production will be the gas-firing of boilers, the gas being obtained from producers worked at low temperature so as to provide by-products from the distillation of coal as a raw material for other industries. As the by-product processes can only be worked with real success on a large scale, this will have to be preceded by a fairly thorough centralisation of electricity supply stations, so that the outputs of the numerous small electricity works will gradually be merged into a few large generating stations of sufficient size to work with the utmost economy. The necessity for fuel economy will also result in the more complete displacement of gas lighting by electric lighting. With electricity generated in modern power-houses, and ordinary metal filament lamps, 750,000 candle-power-hours are generated per ton of coal, compared with 260,000 c.p. per ton of coal when gas and modern gas mantles are used. The extended use of so-called "half-watt" lamps will soon double this 750,000, so that it would require an improvement in gas mantles quite beyond the range of immediate probabilities to equalise matters.

SCIENTIFIC societies and journals which deal with certain special subjects do not appear to have suffered much by the war. This does not mean that those engaged in scientific work have held back from taking their places with the fighting forces; indeed, the rolls of honour of the universities show that exactly the reverse is the case. It may be due partly to the fact that many workers in science are past the military age, and partly also to the diminished number of students, leaving more time for research to those most qualified to carry it out. In certain directions there is even an expansion noticeable in the scope of the subjects dealt with, and we congratulate the editors of the *Archives of the Röntgen Ray* upon their choice of a new and wider title for that important publication. It is the only English periodical dealing with the subject of X-rays in all its bearings, and it naturally embraces radio-activity, in addition to matters concerning the applications of radiations generally as well as electricity to medical purposes. We note that the new title is *Archives of Radiology and Electrotherapy*, so that as broad a field as possible may be covered; and to judge by the issues since this change was made last June there is every reason to expect that this publication will meet with the success it deserves. To the publisher, Mr. W. Heinemann, great credit is due, especially for the excellence of the reproductions of radiographs. Each part is well and fully illustrated, and contains a valuable collection of data relating to cases of some special interest.

Engineering for December 3 contains the concluding article of a descriptive account of the machinery of the motor-ship *Kangaroo*, constructed by Messrs. Burmeister and Wain, Glasgow, and purchased by the Western Australian Government for carrying produce to Britain. The vessel is propelled by twin-screws, each driven by independent six-cylinder Diesel engines on the four-stroke cycle. Each cylinder has a diameter of 22·05 in., the stroke being 29·92 in.; the designed power for each set at 140 revs. per min. is 1125 indicated horse-power, making a total of 2250 indicated horse-power. Much care has been given in this ship to the general arrangement of the main engines and auxiliaries, and the whole design is noteworthy from this point of view. During the trials, at light draught, the full power was developed at 144 revs. per min., and the total consumption of oil-fuel for main and auxiliary engines was then 0·292 lb. per indicated horse-power per hour—a very creditable performance. The speed of the ship at light draught was 11·2 knots. Sir John H. Biles and Co. acted as naval architects for the owners.

M. MAX A. LAUBEUF, late chief constructor in the French Navy, read a paper on submarines at the International Engineering Congress, 1915, in San Francisco, a summary of which appears in *Engineering* for December 3. The present tendencies of the constitution of submarine flotillas appear to be (*a*) coastguard submarines of 350 to 500 tons surface displacement, well armed (*e.g.* two minor torpedo tubes and outer tubes or outer torpedo launching equipment), and having speeds of 14 to 16 knots on the surface, and 9 to 10 knots when submerged; (*b*) squadron submarines having a great displacement (say 1200 tons when submerged), high speed, say 23 knots surface speed and 15 knots submerged, and a powerful armament, say eight inner torpedo tubes and sixteen torpedoes on board. *Engineering* also reprints a paper on the submarine of to-morrow by Mr. L. Y. Spear, read at the Society of Naval Architects and

Marine Engineers in New York. Whatever may be the decision of the U.S.A. authorities as to the surface speed necessary, the author of this paper is firmly convinced of the relatively greater importance of the submerged qualities for this type of boat, and believes that battery capacity and submerged radius of action and speed should not be unduly sacrificed either in the interests of durability or first cost.

OUR ASTRONOMICAL COLUMN.

A NEW COMET.—According to a telegram received on December 5 from Prof. Strömgren, Copenhagen, a message from the Cape to the Astronomer Royal announces that a new comet was observed by Taylor on December 2 in a position "three minutes preceding sixteen minutes south of δ Orionis." It is stated to be moving slowly north, but no indication is given of its magnitude.

THE SOLAR ROTATION.—The detailed account of a valuable spectrographic determination of the latitude variation in velocity of the sun's rotation is presented by Mr. J. B. Hubrecht in a memoir forming part i. of vol. iii. of the Annals of the Solar Physics Observatory, Cambridge (see also Monthly Notices, R.A.S., No. 8). Four series of spectrograms were secured during the first fortnight of June, 1911, with the McClean solar instruments. Each series contained the material—forty-eight plates—from which velocity differences have been derived for pairs of plates taken in positions separated by 90° at intervals of 15° around the sun's limb. The region studied was λ 4300–λ 4400, under a dispersion in fourth order such that 1 Å.U. = 1·13 mm. Attention may be directed to a point regarding the manipulation of the Zeiss comparator; the settings were made by simply pushing the slide, and the readings were taken to 0·0001 mm., with an average probable error per displacement of only 0·0004 mm.

The results obtained indicate that the velocities probably vary regularly according to wave-length, diminishing towards the red, due to some physical cause residing in the sun itself. The distribution of the velocities appears to be consistent with the requirements of Emden's theory of the constitution of the sun.

GALACTIC CO-ORDINATES.—The progress made of recent years in stellar astronomy has directed increasing attention to the employment of a natural system of co-ordinates in place of those based on the arbitrary, ever-changing geo-solar planes of reference. The fundamental plane of reference is obviously determined by the Milky Way, but there remains to be fixed the point of departure in longitude. Unfortunately, from analogy with the standard system choice of this initial point has fallen on the ascending node of the galaxy. Mr. R. T. A. Innes, in advocating the general introduction of secular co-ordinates, pointed out the great economy of effort they afford in connection with the study of the planetary motions, and proposes to fix the zero of galactic longitude by the apex of the sun's way, thus entirely eliminating the effect of precession. In Circular No. 29 of the Union Observatory, Mr. Innes supplies a convenient table for the conversion of equatorial into galactic co-ordinates. The table is calculated on the basis of Newcomb's position of the pole of the galaxy (α 191·1°, δ + 26·8°, and Campbell's determination of the solar apex (α 270·0, δ + 30·0°), and contains the galactic equivalents of every 5° of declination and twenty minutes of right ascension, also galactic parallactic angles for converting north pole position angles into corresponding position angles referred to the north galactic pole.

A MARTIAN CALENDAR.—In Report on Mars, No. 10, Prof. William H. Pickering gives what should prove a convenient calendar for the use of observers of the planet Mars. The Martian year is divided into 669 calendar days of 24h. 38m. 42·04s. each, the planet's sidereal day (*i.e.* time period of rotation) being 1m. 19·39s. shorter. Fifty-six days are allotted to the first nine "months," and one day less to each of the other three. The "week" of seven days is thus retained as a unit. The year commences at vernal equinox, Martian date, March 1 = terrestrial date, March 20. The same report also contains some remarks on the possibility of observing gemination of canals during the coming opposition, and concludes with a discussion of colouring of the markings.

THE CENTENARY OF THE SOCIÉTÉ HELVÉTIQUE DES SCIENCES NATURELLES.

THE centenary of the Swiss Natural Science Society was celebrated on September 12–15. The meeting was a great success, and was marked by two touching ceremonies: the placing of a laurel crown before the monument of Henri Albert Gosse, the gifted apothecary of Geneva, who with Pastor Wyttenbach, of Berne, originated this great national society, and the inauguration of a monument to the Swiss naturalist Forel at Morges. Both these monuments consist of fine erratic blocks, with the head of the naturalist carved in the form of a medallion. One stands in the shady garden surrounding the University of Geneva; the other has been placed in one of the most exquisite spots on the banks of Lake Leman. But it is not in these grand stones that we must seek the record of the fame of those they commemorate. It is in the living society which has carried out the ideals and continued the work of its founders—a society of which Forel formed until three years ago a prominent member—that the glory of these simple lovers of Nature and of their country is to be found.

The primary idea in founding the society was patriotic; a secondary one, dependent on the success of the undertaking, was that the society would be visited by *savants* from all countries, and that it might prove itself a source of light the rays of which should spread over the whole scientific world. Both these ideas have been realised in the hundred years that have passed, but it is interesting that the centenary should fall at a moment when the former only could have any prominence.

There were no official delegates from foreign countries, and practically all the participators were Swiss. The author of the present account was the only member of the English scientific world at the meeting, but she and Prof. W. H. Young, whose absence in America alone prevented his giving personally the communication presented in his name, are accepted by the Genevese scientific circle as almost, if not quite, of them.

In these circumstances, and in view of certain superficial elements of discord between the French and German Swiss, which the war has brought under the eye of the public, the occasion was made one for a manifestation of patriotic feeling. The President of the Confederation was present, and gave a memorable and eloquent address to the society after the official banquet at the Parc des Eaux Vives, lately become the property of the town of Geneva. President Motta is a native of Italian Switzerland, a fact

of no small importance at the present crisis. Switzerland, one and indivisible, her children diverse in speech and modes of thought, only the more efficient for that diversity, were mirrored in that patriotic confraternity of science, inaugurated by a citizen of Romançe Geneva and one of Allemannic Berne. Among the names, too, of the great Swiss naturalists, French and German as they sound, Swiss as they are—Agassiz, de Candolle, Vogt, Forel, Escher, Merian, Studer—whom President Motta cited as written in golden letters in the great book of European science, he placed one more, that of Luigi Lavizzari, not only as worthy of as high a place, but more especially for having devoted his life to the description of the natural beauties of that corner of earth which the president called "his own," which unites on a small surface, eternal snow and plains rich in corn, sombre pines and sweet olive-trees, the severe shadows of the north, and the brilliant lights of southern landscapes.

"How," the president exclaimed, "can one be Swiss without loving Nature? It is the sense of the infinite and the insatiable thirst for perfection and for truth which confer on man, with his royal littleness—the idea is Pascal's—his true greatness. How can one love Nature without loving Science, whose aim is disinterested research, and whose condition of existence is intellectual liberty? And how can we love Nature and Science without being attached to the soil of our country with all the fibres of our heart?

"Certainly the country is not only the soil on which the people dwell; it is more than that; it is composed of the patrimony of the past and the aspirations of the future; it is formed by the holiness of customs and the spirit of institutions; it is the physical and moral tradition which binds the dead to the living and the living to those that shall be born; but the soil remains an essential part of the country. And when this soil itself represents a little world, when it offers to its children the most touching and the most picturesque sights, grace and sublimity side by side, oh! then the soil is sacred. It becomes the source of the sanest thoughts and the purest emotions. It explains in some sort our history and why Switzerland cannot be other than a democracy, that is to say, a popular government aspiring always to more liberty, more justice, and more fraternity; to defend it, to defend this soil, each of us in the hour of danger would be ready, if need were, to sacrifice his blood and his life.

"No," he continued, "none of us will ever admit in our midst the struggles and the competition of races. The present hour, which has given birth in all the belligerent countries to proofs of self-sacrifice and devotion, arousing on our part cries of admiration and of pity, brings out that which is murky, sad, and almost inhuman in these struggles and antagonisms.

"Switzerland will remain for ever a fraternal republic. No one has ever demanded that the differences of race, language, and education should disappear. The ideal of a State like ours is not uniformity; we know that our State would lose a capital part of its force and its value if it ceased to exhibit that variety of tendencies, languages, and methods of education; but variety means emulation and not contrast. . . . To set the Latins against the Germans, as irreconcilable enemies, would be not only a bad deed, contrary to the moral and political constitution of the country, but also an attack on Christianity and civilisation."

In concluding, the president referred in moving words to the work of the Red Cross, and to its founder, the Swiss Henri Dunant. "What more appropriate wish," he cried, "can I formulate for the Swiss Natural History Society than that it should, in the second century of its existence, become the Red Cross of Science, to bind up and to heal the most distressing of ulcers and the most mortal of wounds, those which torment souls and part spirits?"

In spite of the war, which in Switzerland, as elsewhere, has affected scientific productivity, a valuable series of communications was presented to the society. The programme was as follows:—

(1) *Mathematics.*—L. G. Du Pasquier, On systems of complex numbers; G. Polya, Is a series of powers in general capable of analytic continuation?; M. Plancherel, On the convergence of a remarkable class of definite integrals, involving an arbitrary function; W. H. Young, On integration with respect to a function of bounded variation; G. Chisholm Young, On curves without tangents; D. Mirimanoff, On the tile theorem; L. Crelier, On a theorem in kinematic geometry; R. de Saussure, The geometry of *feuillets côtés*; G. Cailler, Analytical discussion of the same. (A *feuillet côté* is a geometrical form consisting of a point, a straight line through it, and a plane through that, all being weighted, or "côté," with an additional number. The theory has much analogy with the theory of screws, but has two more degrees of freedom.) H. Berliner, A new analytic geometry; Gonseth, Two generalisations of a theorem of Poncelet.

(2) *Physics.*—L. de la Rive, On the movement of the ether relative to the earth; A. Hagenbach and W. Rickenbacher, Comparison of the thickness of soap films when measured optically and electrically; E. Guillaume, On Maxwell's law of repartition; C. E. Guye and C. Levanchy, Experimental verification of the formula of Lorentz-Einstein for cathodic rays of high velocity; A. Schidlof, Recent researches into the charge of the electron and Avogadro's number; A. Tcherniawsky and Z. Popoff, The flow of mercury along tinned wires; S. Ratnowsky, The constants of entropy for gases and the theory of rigid bodies; A. Piccard and A. Cherbuliez, A new method of studying paramagnetic salts in very dilute solution; J. de Kowalski, On the radiation of an oscillating electric spark; A. Gockel, On rays which pierce through the atmosphere; J. Andrade, An exact balance for the measurement of horizontal force.

(3) *Geology and Geophysics.*—A. Brun, The action of steam on eruptive rocks at a high temperature; L. Rollier, On the Mesozoic palæography of Switzerland; M. Lugeon, Some new facts in the geology of the Dent de Morcles; R. Billwiller, The chief types of great deposits in Switzerland; A. de Quervain, Report of the Commission of glaciers in Zurich (1915), and the work done in the seismological department of the Swiss Meteorological Institute; J. Maurer, On the repetition of the sun-spot periods in the observations of the Northern Lights made in Switzerland since 1540; A. Heim, On the relation of variations of gravity to the geological structure of Switzerland; P. Girardin, The changes of the limit of perpetual snow in Savoy and the Alps in historic times; L. Collet, The subterranean outlet of the Seewlisee (Uri); A. Buxtorf, The geology of the Grenchenberg Tunnel; B. G. Escher, Stones with furrows and rills.

(4) *Chemistry.*—E. Noelting and F. Steimle, The preparation of compounds with closed chains; E. Noelting and E. Kempf, On the properties of tri-anisylcarbinol for dyeing; L. Reutter, A contribution to the chemistry of the physiological powder of juniper; A. Werner, On compounds containing at the same time asymmetric carbon atoms and an asymmetric cobalt atom; F. Fichter, Electrochemical re-

duction and oxidisation of organic compounds of arsenic; S. Reich, Nitration of phenylpropiolic acid; P. Dutoit, On the mechanism of the formation of certain precipitates; E. Briner, On the formation and the decomposition of the metallic carbures; O. Kaiser, On the hydrocarbons in coal; M. Duboux, On a differential calorimeter; G. de Montmollin and O. Billeter, The action of cyanide of benzine-sulphonyle on sulphuretted compounds; A. Pictet and T. Q. Chou, Direct formation of alkaloids starting with albumines; L. Pelet, On the theory of dyeing.

(5) *Botany*.—A. Ernst, Researches into *Chara crinata*; C. Schroter, Recent researches in botanic geography in North America; P. Jaccard, On the distribution of medullar rays in the conifers; B. P. G. Hochreutiner, On certain new species of Malvaceæ; G. Senn, The distribution of chromotophores in marine algæ; E. Kelhofer, Wooded and cultivated parts of the Jura near Schaffhausen; M. Rikli, The flora of Crete; A. Trondle, On the permeability of the tip of the root; M. Jäggli, The delta of the Maggia and its vegetation; J. Briquet, The vegetable parts of the Cruciferæ sempervivoides.

(6) *Zoology*.—Dr. Thomas, A critical study of mountain sickness; P. Revilliod, Preliminary note on the osteology of the fossil Chiropteræ in Tertiary beds; J. Roux, The family of the Atyidæ; E. A. Göldi, Comparative development in the sexual reproduction of plants and animals; A. Oswald, On the action of the glands of internal secretion on the circulation; A. Burdet, The birds of the island of Texel, Holland; O. E. Imhof, The molluscs of our Alpine lakes; H. Blanc, Contribution to the anatomy of *Chlamydophorus truncatus*; L. Ascher, (*a*) The factors determining the internal secretion of the glandula suprarenales, (*b*) the innervation of the liver; (*c*) the acoustic properties of the canales semi-circulares; A. Lipschütz, The importance of physiology in the study of development; E. Yung, The effects of inanition on the cell; A. Gandolfi, Observations on the distribution of *Daphnia hyalina* in the Lake Leman; E. André, The balantidium of the amphibians.

(7) *Entomology*.—C. Emery, History of an experimental society of amazon ants; J. L. Reverdin, Revision of the palæoarctic species Hesperia; E. A. Göldi, New discoveries in the origin of sex, the determination of sex, and the proportion of the sexes in insect states, particularly in the cases of the honey-bee and the neotropic ants; F. Ris, Census of the Swiss Plecoptera by F. J. Pictet in 1841 and nowadays; O. Schneider-Orelli, On the biology of *Phylloxera vastatrix*; F. Brocher, The circulation of the blood in the wings of the Dyticidæ; C. Ferrière, The utilisation of insects which eat other insects; H. Faes, On the value of the powder of pyrethra obtained from indigenous plants for insecticide purposes; A. Pictet, Hereditary and individual reactions in insects.

(8) *Anthropology and Ethnography*.—Dr. Lardy, The grotto of Cotanchere; H. Lagotala, Study of a hundred Genevese femurs; Dr. Montandon, The instruments of music in the ethnographic museum at Geneva; R. Montandon, The handling of stones at the Moustierian station of Rebières; Prof. Schlaginhaufen, The Neolithic lake-dwellings of Egolzwil; E. Matthias, The influence of physical exercise on growth; A. Schultz, New projective measurements of the skull; H. Hoessly, Craniological investigations among the east Eskimos, after the Greenland expedition of 1912; A. Cartier, The chief discoveries at the Magdalenian station of Veyrier; E. Pittard, Castration and the morphological modifications which it causes in man.

On September 13 and 15 lectures were given to the assembled society in the Aula of the University. Prof. Emile Yung, the eminent Genevan zoologist, gave an interesting account of the first century of the society, and laid before the meeting the *Livre du centenaire*. The venerable geologist, Prof. Albert Heim, the friend of Forel, spoke on fresh light in the investigation of the Jura Mountains; Prof. P. L. Mercanton, of Lausanne, reported on forty years' mensuration of the Rhone glacier; Dr. Fritz Sarasin, of Basel, the well-known traveller and archæologist, gave a lecture, with lantern-slides, on an archipelago in the Pacific Ocean—the Loyalty Isles; and Dr. E. Rübel, of Zürich, spoke of the international botano-geographic expedition to North America, also with magic lantern. But the most remarkable was the opening discourse of the president, Prof. Amé Pictet, of Geneva. It dealt with molecular structure and its influence on life and death. What, he asks, is it that renders matter living? And, again, what is it that renders some matter injurious and some harmless or beneficial? To study these profound questions, Prof. Pictet turns to the vegetable world, as more fundamental in the scale of life than the more dependent animal realm. It is the plants, indeed, that are able to perform the synthesis of organic substances on which all life seems to depend. In the vegetable world it is the group of poisons known as the alkaloids which have yielded up their secret to Prof. Pictet's patient study. His theory is that it is to the molecular constitution that we must look. It has been shown that all the organic compounds known belong to two types of molecular structure: (1) open chains, and (2) closed chains. These two classes of compounds are separated by a great gulf; but it is not impassable. The passage from the open to the closed chain can be effected with comparative ease by means of chemical reactions, but the reverse process is difficult. The closed chain is a very stable molecular form, and this it is which Prof. Pictet connects with death. Life is, roughly speaking, the passage of all open chains to the closed form. Such closed chains may be, and indeed must be, formed from time to time in the organism, and constitute the life in death, from which the animal tries to free itself by excretion. The plant cannot do this, but it protects itself internally from these dangerous products. Such are the essential oils, turpentines, and camphors, which constitute so many of our perfumes; such, again, are the caoutchoucs and tannins, the vegetable colouring matters, and the deadly poisons hidden in various plants. These, Prof. Pictet tells us, are products of denutrition; they are like our so-much-talked-of uric acid. We find them, not in the living cell, but packed away in dead cells, and often wrapped round with protecting covers to prevent them from harming the living plant. Thus, he concluded, the serpent who bites his own tail, which was the symbol of eternity with the ancients, deserves to become for the modern biochemist the symbol of death.

GRACE CHISHOLM YOUNG.

THE CONCH SHELL OF INDIA.[1]

THE conch or chank shell (*Turbinella pyrum*) is so intimately connected with the religious and social life of the people of India that the monograph on the subject prepared by Mr. J. Hornell, Superintendent of Pearl and Chank Fisheries to the Government of Madras, is welcome. He has gained in the course of his official duties a knowledge of the industry in Madras, and he was recently deputed by

[1] Madras Fisheries Bureau. Bulletin No. 7. "The Sacred Chank of India: A Monograph of the Indian Conch (*Turbinella pyrum*)." By J. Hornell. Pp. viii+181+18 plates. (Madras: Government Press, 1914.) Price 3s.

the Government of that province to investigate its conditions in other parts of the country.

Among the five areas in which the shells are collected—Tinnevelly, usually known as the Tuticorin fishery, Ramnad, the Carnatic Coast, Travancore, and Kathiawar—the first is the only place where it is carried on systematically, and it has existed here for at least 1800 years. Early evidence of the use of the shell is found in the Foote collection of Indian prehistoric antiquities in the Madras Government Museum, and more recent excavations, conducted by Mr. A. Rea, have furnished additional examples. In Mysore the specimens have been supposed to date back to Neolithic times, but as the shells cannot be worked without a metal saw, they probably belong to a later age, that of iron.

In Tinnevelly, where the industry is carried on under official superintendence, about seventy divers are employed. In favourable circumstances, a diver may in each excursion to the beds make twenty-five descents, each yielding from nothing to eight shells. These on reaching the shore are classified in nine grades, ranging from 4 to 2½ inches in diameter; the wormed shells, being of inferior value, are placed in a special category.

The chief economical value of the shell is for the production of bangles or bracelets, the object of wearing them being partly for purposes of ornament, partly as a protective against evil spirits and the evil eye. While the source of supply is mainly southern India, the manufacture of bangles is now practically confined to Bengal. Mr. Hornell suggests that this transference of the manufacture took place in the fourteenth century, which marks the downfall of Hindu supremacy in the south, when the rich cities of the Pandyan kingdom were sacked by the Mahomedans, and the coast trade passed into Arab hands. At the present day the shells are imported to Calcutta, and pass thence to Dacca and other centres in Bengal, where they are cut by the Sankhari caste, which holds a high place in the Hindu social system. The wearing of chank bangles is now virtually confined to Lower Bengal and the hill tribes north and east of the province, from the Santals to the tribes of Assam and Manipur, and from the Sunderbuns to the Himalayas and the Tibetan plateau. Some 2⅓ million shells appear to be worked up annually in Bengal. The columella is first extracted by sawing off a slice of the lip and smashing the apex. The sawyer sits on an earthen floor tightly wedged between two short wooden stakes driven into the ground, one supporting his back and his toes against the other. He presses with one foot a disc of hard wood against the mouth aperture and divides the shell into sections with a heavy saw, the blade of which is in the form of a crescent ending in a hook at each end. The use of any more elaborate machinery is unknown. He is paid about one rupee for every ten shells he cuts. The work is very fatiguing, owing to the constrained position of the artificer.

Besides being cut into bangles, the shell supplies other forms of ornament, rings, necklaces, coat or dress buttons being made from it. Up to quite recent times these shells were used as currency in the Naga Hills. Some of the fragments are burned into a fine lime, used for industrial purposes and as a cure for various diseases, such as rickets, asthma, and cough. This is justified by modern medical research, the lime being useful to strengthen the bones of rickety children or by the deposit of salts round tuberculous centres. A minor use of the shell is to supply the equivalent of our infants' feeding-bottles.

Besides these economical uses of the shell, it is employed in various ways connected with the religious and social life of the Hindus. It is the emblem of the god Vishnu, and when the convolutions take the sinistral or left-hand form it is highly valued, and deposited in temples of the god. The four daily services at a Hindu temple are announced by blowing the shell, which in ancient times was also used as a war trumpet. No one who has encamped near a Hindu temple will forget the weird muffled roar which calls the god to wake at early dawn and receive the service of his worshippers. Beggars blow the shell as an appeal for alms. It is specially valued as a protective against the evil eye, and hence water is poured from it on the foundation-stone of a temple or house, or it is hung round the necks of children or cattle. It is blown at harvest when a man undergoes a special purification and is sent to cut the first-fruits, and at marriages to scare the evil spirits which beset bride and bridegroom. With the same object it is sounded when a corpse is being carried to the funeral pyre or to the burial ground.

On the whole, this survey of one of the purely indigenous industries of the country, the products of which are all locally absorbed, is of sufficient interest to justify the labour which Mr. Hornell has undertaken in collecting the materials for his excellent monograph.

LUMINOUS INSECTS.[1]

THE power of emitting light at night is a property that has been developed to varying extent in many different branches of the animal kingdom. We find it, for instance, in the Protozoa, *e.g.* Noctiluca, an organism which, though microscopic in size, is sometimes present in such countless millions on the surface waters of the ocean as to make the whole sea appear to be ablaze with a pale, cold, "phosphorescent" light. Higher in the animal scale we find the property well developed in the Hydrozoa, *e.g.* Pyrosoma, a colonial oceanic form. We have it again in numerous molluscs, in the insects, and even in the vertebrates, a large number of the fish that inhabit the abysmal depths of ocean, where the sun's rays can never penetrate, carrying their own lamps disposed about their bodies in patterns that vary according to the species. Here, however, I propose to consider only the insects that exhibit this power.

There is, as might be expected considering the striking nature of the phenomena in question, a very extensive literature on the subject. This is for the most part scattered throughout numerous scientific periodicals, but the earliest part of it, up to 1887, has been collected together by Gadeau de Kerville in his "Insects Phosphorescents," published in that year.

It is rather remarkable that the beetles (Coleoptera) have almost a monopoly of light emission amongst insects, and even here the property is almost confined to two families. The first, and by far the most important of these, for our consideration, is the Lampyridæ, or, to give them their popular name, the glow-worms and fireflies. With them are associated one or two small closely allied families, the Phengodidæ, Rhagophthalmidæ, etc., some of which are as yet very imperfectly known and unsatisfactorily characterised. In the Lampyridæ proper the luminous organs, when present, are generally found in both sexes, though frequently more strongly developed in one than in the other, and are situated in the terminal or subterminal segments of the abdomen, the light being shown from the ventral surface.

All members of this society are familiar with the glow-worm of this country, *Lampyris noctiluca*. I

[1] From a paper read before the South London Entomological and Natural History Society by K. G. Blair.

will remind you that in this species, in the adult stage, the light-giving property is practically confined to the female. Destitute of wings, she is rather an unlovely object, doomed to crawl about amongst the grass and low herbage, while her prospective spouse enjoys the freedom of the air above her. Yet her light is emitted from the underside of her tail, a situation that would not at first sight appear to be particularly well chosen as a source of illumination. Her *modus operandi* in exhibiting her light is usually to climb a little way up some convenient stem and to sit there with her lamp suspended, her body twisted a little to one side so as to exhibit the light without obstruction. If she can find no stem stiff enough to bear her weight she will remain with her body on the ground, the abdomen twisted to one side to expose the light as freely as possible, turning it first to one side then to the other in her attempts to attract the attention of wandering males. At Lugano Mr. H. Main and I have observed that they were particularly partial to old walls, even sitting 10 or 12 ft. above the ground. Though we found the larvæ fairly plentiful in the grass the female beetles were always on the walls, and in such a situation their light was plainly visible from a long distance; the twisting motion of the abdomen was also clearly observed.

Luminous organs are present in the male glow-worm in a similar situation, but to a very minor degree. The extent to which they are functional possibly varies in different localities. It is probable that in this sex the light is emitted only for a comparatively short time after reaching maturity, and that it soon becomes exhausted.

Photogenic organs are also present in an advanced degree in both the larva and the pupa; even the eggs are luminous, though there is here no definite light organ, but the whole surface glows faintly.

To the same family belong the "fireflies" of southern Europe. Of these there is a considerable number of species, which possibly present slight differences in the details of their light emission. One of the best known is *Luciola italica* of northern Italy, a species the habits of which Mr. Main and I had the pleasure of studying at Lugano.

Luciola italica was observed on the evening of our arrival at Lugano, in the grounds of the school, near the lake. Though abundant after dark, they were scarcely to be observed during the day. The first flashes were seen about 8.30, while the lingering daylight was fairly strong, and they were most numerous about 9.30 or 10, after which time their numbers noticeably decreased, though they could still be seen from our bedroom windows well after 11 p.m.

As was to be expected, all the fireflies caught on the wing were males. They have a fairly steady, not very rapid, flight, and flash their light at almost regular intervals, but they do not obviously appear to be searching for the females. When they do perceive an answering flash—and the discovery seems to be a matter of accident rather than the result of deliberate search—they pause in their course, and then fly down to it, although they may be as much as 10 ft. away.

The females were never observed to use their wings, but were always found on the grass or the herbage. In these insects, unlike the American Photuris, etc., observed two years ago, the initiative in seeking a mate appears to be with the female, as in the case of Lampyris. At times they will be quite dark, while sometimes they will glow with an almost steady, though not very bright, light. When "calling" for a mate, however, they flash with rather long slow flashes, incompletely extinguished in the intervals. Such a period of flashing is usually of short duration, and is succeeded by a dark period. It is this succession of slow flashes that bears the appearance of definitely calling for a mate, and during which the males most readily approach her, though they are also attracted to some extent by a steady glow.

The males, both in captivity and in nature, *i.e.* when caught in a spider's web, were observed to glow with a constant though not very brilliant light, somewhat resembling the steady light of a female, but no case of flying males approaching these dead males was observed.

The mating habits of many American species of Lampyridæ, popularly known as lightning-bugs, have been investigated recently by McDermott.[2] In these insects, as in the European Luciola, both sexes are luminous, and the light is emitted as a series of coruscating flashes. Again, the male has the more brilliant light, but in these insects he seems to take the initiative in searching for a mate, hovering over the ground flashing his lamp, and apparently watching for an answering flash from the less active female concealed in the grass.

The lightning-bugs investigated by McDermott belong mainly to the genus Photinus, of which the species are numerous, two or more of them often being found on the same ground. The results of this investigator's observations, assisted by a series of ingenious experiments with small electric bulbs which could be operated to simulate the flash of the insect, conclusively show that each species has its characteristic method of exhibiting its light, and that an individual of any one species will in general only reply to, or evoke a reply from, a member of the opposite sex of that species. He found, however, that some species would respond much more readily to his artificial flashes than others, and that some would even answer the flash of a match.

A few details of his observations on certain species may perhaps be quoted:—

Photinus pyralis.—The flash of the female is given three or four seconds after that of the male, and is of the same colour, but of longer duration and less intense.

Females would answer in numbers to the flash of a match swung in an arc to simulate the flash of a male, though as a rule not more than one female would reply to a flashing male.

A particular female would not reply to the flash of a male of another species (*P. consanguineus*) though she would to that of a match.

The male could also be deceived by a bulb placed in the grass and flashed three to five seconds after his own flash; when the bulb was flashed without the pause it was not so effective.

No male was ever observed to reply to the flash of a creeping male.

P. consanguineus.—The male gives a double flash, two flashes in quick succession followed by a pause, then two more, and so on; the female replies within a second to the second flash of the male.

A particular female would not reply to the flash of a match, but would answer the double flash of a bulb when 20 or 30 ft. away; on a nearer approach she seemed to recognise something unusual and would no longer reply.

P. scintillans.—The male gives a short single flash and the female a longer single flash; the female in this species is apterous.

A female would reply to the first flash of a male of *P. consanguineus*, but the latter takes no notice.

P. marginellus.—The male gives a single short sharp

[2] *Canad. Entom.*, 1910, pp. 357–363; 1911, pp. 399–406; 1912, p. 73 and pp. 309–312.

flash, yellower than that of *P. scintillans*; the female replies with a double flash, the first sharper and brighter than the second, followed at once by the second. The reply is given very quickly after the flash of the male.

P. castus.—The male gives a single flash, not so short and sudden as that of *P. marginellus*; the female gives a single flash very much like that of *P. scintillans*, but delivered immediately after the flash of the male; there is no distinct pause as in *P. pyralis*, and no indication of doubling as in *P. marginellus*.

P. castus and *P. marginellus* are very similar, and, indeed, by some authorities, have been considered to be merely forms of one species. Mr. McDermott admits that he can find no points of structural difference between them, but considers them distinct species on account of the very different flashes emitted by them. They are frequently found flying together, but no case of interbreeding has been observed, though especially watched for.

Mr. E. E. Green[3] has published notes on the use of the light by certain species of luminous beetles in Ceylon. Of these, one, *Lamprophorus tenebrosus*, Walk., belongs to the Lampyridæ properly so called. The female of this species is apterous with a ventral subterminal light-organ which she exposes much in the manner of our glow-worm. The male, though normally brilliant, approaches a "calling" female with the light shut off, its advent being heralded only by the partial extinction of the light of the female.

The other species mentioned by Mr. Green present certain marked differences from normal Lampyridæ in the emission of their light as well as in structural points, and have been placed in a separate family, Rhagophthalmidæ. Concerning the light of *Dioptoma adamsi*, Pasc., Mr. Green notes the larviform female was observed to recurve the body over the back so as to expose the ventral subterminal light organ. On the approach of the male the light was partially eclipsed and the tail turned down. The male at the time was not known to be luminous, but under the stimulus of sexual excitement, it was observed to exhibit a row of luminous spots along each side of the abdomen, as well as dorsal spots on the abdomen and across the base of the thorax.

I have recently received from Mr. Gairdner, of Bangkok, some females of a glow-worm which, he reports, turn up their tails to exhibit the light in a similar way to Dioptoma. Like the female Dioptoma, too, they are of a more degenerative type than Lampyris females, the antennæ and legs being small and feeble with a reduced number of joints.

Allied to these and to the Lampyridæ is another small family, the Phengodidæ, many of the members of which possess very remarkable luminous properties. In Brazil and Argentina, for example, is an insect that on account of its peculiar scheme of luminosity has long been known as a "railway" larva. The head of this creature glows brightly with a red light, like a live coal, which is more or less intermittent in character, while along each side of the body is a row of more constant lights, green or yellow, or even changing at intervals from a bluish to a more yellow hue. For many years these "railway" larvæ were nothing more than a puzzle to entomologists. On account of their light-giving powers they were usually considered to be lampyrid larvæ, though nothing else like them was known. Still less were they like the larvæ of the only other known luminous coleopterus family, the Elateridæ. The astonishment was great when in 1885[4] it was announced that the botanist, Hieronymus, had found one of these so-called "larvæ" mated with a beetle belonging to the genus Phengodes. Eggs were obtained from it which in due course produced larvæ, thus proving that the supposed larva was in reality the sexually mature, though degenerate and completely larviform, female of a beetle.

We are now confronted with the very interesting question as to whether the apterous, more or less larviform, state of the females of many of these glow-worms is a primitive condition or the result of degeneration from an earlier, higher, winged type. Riley[5] states that the female larva of *Phengodes laticollis* and *Zarhipis riversii*, both North American species, goes through a pseudo-pupal state prior to the final moult. It appears, therefore, that this larviform female is a mature though degenerate female, and that we have not here to do with a case of pædogenesis; *i.e.* of the larva becoming sexually mature without the attainment of somatic and metamorphic maturity.

The same writer considered that we here "get a glimpse, so to speak, into the remote post, from which has been handed down to us, with but little alteration, an archetypal Hexapod form which prevailed before complete metamorphosis had originated." Were this really the case, it is difficult to account for the occurrence of a pupal state in the individual development of the female, though this might perhaps be interpreted as a partial transference from the metamorphosis of the male. Further, if the larviform condition is to be explained as a case of arrested development and the persistence of a primitive type, either one would expect to find it fairly constant in a group of closely related species, and genera evidently arising from a common ancestry, or it must be considered as a kind of throw-back or reversion to an ancestral type.

For my part I prefer to regard the theory of degradation from an earlier winged type as affording a better explanation of the facts as we find them. We have the successive stages in such degeneration all illustrated, from the fully winged though sluggish female of Luciola, through the brachypterous state found in the females of certain species of Photinus, down through the apterous but otherwise developmentally mature females of Lampyris, and the more degenerate type of female of Dioptoma to the completely larviform females of Phengodes. The steps in this series do not imply relationship or common ancestry, but merely indicate the points, successively further and further back in the phylogeny of the group, when the use of the wings in the course of any particular line of development was discarded and their consequent degeneration set in, or, to put it briefly, that the apterous condition is of polyphyletic origin. I know of no instance among the Lampyridæ, such as we have amongst the Lepidoptera with apterous females (*e.g. Anisopteryx aescularia*) where, though wings are wanting in the adult, there are well-developed wing rudiments in the pupa, but I have found one female of *Lampyris noctiluca* with the wing and wing-cover well developed, though shrivelled, on one side of the body.

With the question of the evolution of the apterous female is bound up the question of the evolution of the power of luminosity. Many members of the family Lampyridæ are probably not luminous at all. Pale yellowish abdominal spots are almost always to be detected in the region of the luminous organ, but whether the species possessing them are always luminous is open to doubt. Our knowledge of the habits of many of these insects is extremely defective, and it is frequently impossible to say from dried specimens whether a species is or is not luminous.

3 Trans Ent. Soc., 1912, p. 717.

4 Haase, *Sitzung. Natur. Ges. Isis.*, p. 10; and *Deutsche Ent. Zeit.*, xxxii., p. 154; "Camb. Nat. Hist. Ins.," part ii., p. 251.

5 *Ent. Mo. Mag.*, xxiv., 1887, p. 148.

In most of the luminous species the eyes, particularly of the males, are extraordinarily large and well developed (*e.g.* Lampyris, Photinus, Luciola, etc.), but the antennæ are simple. In the non-luminous species, on the other hand, the eyes are of a more normal size, but the antennæ of the male are frequently strongly plumose (*e.g.* Cladodes, Lamprocera, etc.), a feature that in this order as in the Lepidoptera is usually regarded as indicative of a highly developed sense of sex-perception in this sex, correlated with the possession of sluggish and retiring habits on the part of the female. It is noteworthy that in the genus Phengodes both the plumose antennæ of the male and the powers of luminosity of the female are unusually well developed.

Undoubtedly the chief function of the light is in securing the mating of the sexes, but that this is a secondary function only is evidenced by the different degree to which the use of the light is developed. Its wide occurrence within the family proves that the power of emitting light must have arisen early in the evolution of the family, though exactly how it originated it is impossible to say. Possibly, it may have served at first as an indication of unpalatability, common to both sexes, and then, coming under the influence of sexual selection as an evolutionary force, have developed along the various lines we see indicated. In connection with their unpalatable qualities, it may be noted that the Lampyridæ is a family that has many mimics in other families of beetles, amongst the Telephoridæ, for example, and the longicorns. Species of the longicorn genera Amphionycha and Dadoychus even go so far as to have a ventral pseudo-luminous patch resembling the luminous patch of the fireflies, but in the allied genus Alampyris, where the dorsal mimicry is quite as close, this patch is lacking.

Apart from its principal function in securing the proper mating of the sexes, the light seems also to be largely used, at any rate by the males, for purposes of display. Where the powers of luminosity are largely developed in this sex the emission of the light is usually of an intermittent flashing type. It has been noticed in various parts of the world that these flashing males tend to congregate in large companies, and that all the individuals of one of these gatherings will flash in concert. All the fireflies around one tree or group of trees, for instance, will flash together, while those around a neighbouring tree will be pulsating to a different time. This feature has been observed of a European species of Luciola (though Mr. Main and myself were unable to detect anything of the sort with *L. italica* at Lugano), of an Indian lampyrid, genus not stated, and of the genus Aspidosoma in South America. The American species of Photinus and Photuris do not seem to possess the habit.

The exact reason of this flashing in concert, or the method by which it is brought about, have not been ascertained. It has been suggested that the light is not really intermittent in character, but merely appears so owing to its being alternately masked and exhibited by movements of the creature's body, and that a slight puff of wind might perhaps affect all the members of a company and cause them all to conceal their lights at once. Though this explanation of the intermittent character of the light applies well enough to Pyrophorus, an insect we shall shortly consider, it is certainly not applicable to these Lampyridæ. It is true the light is not absolutely extinguished between the flashes, but it is so diminished as to become practically dark; moreover, the flashing in unison is too regular to be caused by chance puffs of wind. A more probable explanation of the phenomenon is that each flash exhausts the battery, as it were, and a period of recuperation is required before another flash can be emitted. It is then conceivable that the flash of a leader might act as a stimulus to the discharge of their flashes by the other members of the group, and so bring about the flashing concert by the whole company.

The physical and chemical nature of the light of these insects have been the subject of numerous investigations. Though often spoken of as "phosphorescent," the light has nothing whatever to do with the oxidation of phosphorus.

The most recent conclusions are those of Dubois, and were summarised by him in a communication to the Zoological Congress at Monaco in 1913. He finds that the mechanism for the production of light is the same throughout for both plants and animals, and is the result of the action of an oxidising zymase upon an organic proteid product in the presence of water. In the case of luminous insects the proteid, which he calls *luciferine*, is contained in the form of granules in the photogenic organ, while the zymase, to which he applies the name *luciferase*, is dissolved in the blood. The light is given off by the action of the luciferase on the luciferine as the blood passes through the luminous organs. This zymase can be replaced experimentally by a chemical oxidising agent such as permanganate of potash, lead dioxide, hydrogen dioxide, etc.

The luminous organs in these insects are found on dissection to be abundantly supplied with tracheæ, which open by means of very large spiracles. It is probable that by opening or closing these spiracles the insect is able to regulate the supply of oxygen to the luminous organs, and so in some degree to control the emission of light.

Though in many species the flashing of the male is so regular as to suggest its being due to reflex rather than to voluntary action, yet in the female the light appears to be more under the control of the insect. In many species the light may be emitted after the death of the insect, but in the case of males of the flashing species the light is then constant instead of intermittent and less intense than in life. While searching for the females of *Luciola italica*, I was several times deceived by the constant faint light of a dead firefly caught in a spider's web near the ground.

Another group of beetles the light-giving properties of which have caused them to be very widely known—at any rate by name—are the "fireflies" of tropical America, Pyrophorus. These must not be confused with the "fireflies" of Italy and southern Europe, which, as I have said, are really winged glow-worms allied to the lightning-bugs of the United States. The fireflies of tropical America and the West Indies, the creatures that the local belles wear in their hair, and about their persons, as a kind of living jewelry, known locally as Cucujos, belong to a very different family, the Elateridæ, or skip-jacks. They are considerably larger than the glow-worms, and their light organs are differently situated. The most obvious are a pair of large yellowish spots on the thorax, one near each of the posterior angles. If the beetle is examined alive, these spots, the "eyes" as they are called, will at first be quite dull and opaque; but when the insect is handled they will soon be observed to kindle, the glow increasing gradually in intensity until it reaches its maximum. This light is only emitted by the firefly when stimulated by some excitement, such as that caused by handling, and glows steadily so long as the excitement continues; as this wanes the light gradually dies away.

When the insect is on the wing the light seen is

not that emitted from these eye-spots, but originates from another light organ at the base of the abdomen. This organ is usually concealed between the abdomen and thorax, and is only exposed when the elytra are open so that the abdomen can be bent back. The light is of a redder, or yellower, colour than that emitted from the thoracic spots; and is intermittent instead of continuous, the flashes being caused by slight movements of the abdomen, whereby the light is alternately concealed and exhibited. The bionomic value of the light in these insects is not at all understood, but it does not seem to have any sexual function in this case.

The larvæ of these fireflies are also luminous. They are of typical elaterid form and live in rotten wood. In the young larvæ the light is emitted from the junction of the head with the body, but in the older larvæ it is emitted also from the junctions of the segments all along the body. The eggs also are stated to be luminous.

Various beetles of other families have been recorded as luminous, but all these records want confirmation, and some of them were certainly only accidental.

To sum up, nearly all the cases of luminous insects, and *all* those that are in any way well known and common, belong to the order Coleoptera, and even here almost entirely to the family Lampyridæ. An exception to this statement is found in the elaterid genus Pyrophorus, but other records all require confirmation. In the Lampyridæ the light plays an important part in securing the mating of the sexes, but its functions in other luminous beetles have not been satisfactorily explained.

In other orders of insects luminosity is rarely met with, at any rate in the normal condition of health; little or nothing is known of the part that it plays in the life of the animal; indeed its very existence, apart from what we may call accidental causes, is usually more or less problematical.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The Romanes lecture—subject, "Science and the Great War"—was delivered by Prof. E. B. Poulton on December 7 before a large audience, which followed with marked interest and frequent applause the scathing indictment brought by the lecturer against the ruling powers of this country for their neglect of the teachings of science with regard to the conduct of the war. Prof. Poulton showed how by their refusal to benefit by the expert knowledge which might have been at their command for the asking, the Government had actually played into the hands of the enemy. This was especially apparent in the case of the materials for the manufacture of high explosives and in that of the importation into Germany of foodstuffs. The evil had to some extent been stopped, thanks, in the matter of cotton, to agitation by the Press; but it was still far from being at an end. The most deadly kind of war was one waged by a ruthless enemy employing to the full all the resources of modern science. Such an enemy we were now being called on to face, and our only hope of success lay in using those means which were ready to our hands if the authorities could be induced to apply for information and assistance in the proper quarters.

SHEFFIELD.—At the annual meeting of the court of governors of the University, it was announced that one outcome of the war was the establishment of a department in the scientific teaching of glass-making. The industry, an important one for the rougher kinds of work in south Yorkshire, had previous to the war to cope with serious German competition. The time is suitable to encourage this industry when it is relieved from German rivalry, and it is hoped that the University's efforts will be directed towards the finer kinds of glass work in which this country did but little in the past. A lecturer and a demonstrator in glass manufacture have already been appointed.

The great demand for medical men and the undesirability of discouraging suitable students, especially women, has resulted in the University deciding that Latin is no longer required as a subject in the matriculation examination for the medical degree. The new regulation continues until the University shall otherwise determine.

THE list of past and present students and staff of the Imperial College of Science and Technology serving with H.M. Forces, issued in May last, has been corrected so far as possible up to May 27. An analysis of the roll gives the total in connection with each of the constituent colleges. The grand total of present and past students and members of the staff was, in the case of the Royal College of Science, 161, the Royal School of Mines, 305, and the City and Guilds (Engineering) College, 719, being 1185 in all. Of this total 376 were present students, 739 past students, and 70 members of the staff, 715 of the total being officers.

As has been already noted in these columns, Columbia University received by the will of the late Mr. A. F. Eno the residuary estate. It is now announced in *Science* that Columbia University also receives a reversionary interest in certain bequests, and bequests of 50,000*l.* each are made to New York University, the American Museum of Natural History, and the Metropolitan Museum of Art. Our contemporary also records that Mr. and Mrs. Norman W. Harris, of Chicago, have increased their gift of 5000*l.* to Mount Holyoke College made at the time of the seventy-fifth anniversary, to 10,000*l.*, for the endowment of the chair of zoology.

THE annual meeting of the Mathematical Association will be held on Wednesday, January 5, at the London Day Training College, Southampton Row, London, W.C. The following addresses will be given:—(1) The aims of education, a plea for reform, (2) The allowance for the earth's rotation in the theory of projectiles, Prof. A. N. Whitehead; The results of an investigation into the degree of accuracy that may be expected in simple arithmetical work in boys' schools, G. W. Palmer. There will be a discussion on (*a*) the use of mathematical tables in schools, and (*b*) desiderata in a book of such tables for school use, to be opened by Mr. A. Lodge.

IN a recent publication of the Department of Agriculture and Technical Instruction for Ireland (Dublin, 1915) Mr. E. P. Barrett deals with suggestions for the teaching of the first year's syllabus in experimental science in secondary schools. The proposals mainly refer to the use of graphs, with special application to the experimental determination of the relations between connected quantities. Unfortunately, however, the author overlooks the necessity of drawing graphs between quantities of the same kind in their proper proportions, and his figure makes the circumference of a circle appear to be about one and a half times its diameter, a mistake for which hundreds of marks are probably lost every year by examination candidates.

A COPY has reached us of the prospectus of the School of Tropical Agriculture, Peradeniya, Ceylon, of which the Director of Agriculture is the Principal. The school is situated close to the Botanic Gardens, and is intended for boys of seventeen years of age and over who have passed the eighth standard of the

Education Department or its equivalent. An elaborate scheme of work is set out for the course of instruction, including chemistry, plant diseases, agricultural engineering, animals, co-operation, etc., which is to cover a year of three terms. Three examinations are arranged for during the course, and a certificate is to be granted at its conclusion. If the students succeed in gaining a sound knowledge of even a quarter of the subjects detailed in the prospectus, the school may perhaps be considered to justify its existence, but it would seem impossible in so short a time as a year for a real grasp of tropical agriculture to be gained by the students. Lectures and demonstrations are to be given by the staff of the Agricultural Department, an arrangement which bids fair seriously to hamper the legitimate work of the agricultural officers if the syllabus is to be followed and not to be merely a grandiose paper scheme.

THE Appointments Board of the University of London was appointed by the Senate in 1909 to assist graduates and students of the University to secure appointments. During the past academic year the Board has secured more than 100 appointments for its clients. In the last report of the Board to the Senate attention is directed to the special assistance which has been given recently, in filling the vacancies caused by men enlisting, by the appointment of women graduates to them. The services of educated women are proving of great value in boys' schools, in business offices of every kind, and in the various Government departments. The secretary to the Appointments Board, University of London, will be glad to assist employers by giving names of suitable women graduates still disengaged.

THE Cambridge University Calendar for the year 1915–16 has now been issued by the University Press. The present edition contains an index of complete degrees *honoris causa*, in addition to the index of titular degrees which appeared last year. A separate section on the war has also been added, and an annotated list of presidents of the union, from the foundation of the society in 1815, appears in the appendix. In other respects the edition of last year has only been brought up to date. Since the section on the war was sent to press, a supplementary war list has been issued by the *Cambridge Review*. From this it appears that the total number of members of the University on service is now 10,250, and of these nearly one in seven is numbered among the killed, the wounded, or the prisoners, while more than 300 have won distinctions in the field.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 2.—Sir J. J. Thomson, president, in the chair.—W. H. **Young**: Note on the existence of converging sequences in certain oscillating successions of functions.—S. A. **Shorter** and S. **Ellingworth**: The emulsifying action of soap—a contribution to the theory of detergent action. (1) The hydrolysis alkali in a soap solution is capable of assisting in the formation of the soap absorption layer by interacting with free fatty acid in an oil. (2) The "surface activity" of the hydrolysis alkali, in case of oils containing small amounts of free fatty acid, is much smaller than that of the undecomposed soap. (3) Surface activity of free alkali in soap solution is less than that of the same concentration of alkali in water. (4) Addition of alkali to soap solution increases surface activity of soap. This effect is much too large to be explained by suppression of hydrolysis. It is suggested that the effect is due to increase in colloidal nature of "semi-colloidal" soap solution.—P. E. **Shaw**: The Newtonian constant of gravitation as affected by temperature. (1) It has been found possible (*a*) to obtain consistent cycle readings in a gravitational experiment of the Cavendish type, even though the large masses are maintained for hours above 200° C., while the small masses remain at ordinary temperatures; (*b*) to carry on this investigation in the centre of a city at any time by day or night, in spite of tremors and the special disadvantage of having the torsion balance in a vacuum. (2) The conclusion reached is that there is a temperature effect of gravitation. When one large mass attracts a small one the gravitative force between them increases about 1/500 as temperature rises from, say, 15° to 215°. Provisionally, the result is stated as $+1{\cdot}2+10^{-5}$ per 1° C. The readings are not steady enough to justify the statement that there is a *linear* relation for G/θ. Time may be a factor in the effect, but the net result has not been shaken by a long series of tests. (3) The above result, though new, is not entirely unsupported by other experiments, for previous work yields indirect evidence of a positive temperature-coefficient. The weight experiments of Poynting and Phillips, which yielded negative results, are not strictly comparable with the author's. (4) As a by-product of these experiments, it was found that silver bars of the highest purity, after being heated to 130° C. and kept in a strong magnetic field, were permanently, though weakly, magnetised, and that the coercivity was considerable.—G. I. **Taylor**: Skin friction of the wind on the earth's surface. The amount of the skin friction between the wind and the surface of the earth is calculated from observations of wind velocity at different heights above the ground. It is found that the skin friction force acting on unit area of the ground is proportional to the square of the wind velocity, and that its actual value is of the same order as, though probably smaller than, that found by experimenting with flat plates and pipes in the laboratory. The object with which the investigation was undertaken was to find out whether the skin friction on a small surface is nearly equal to that on a very large surface; but if it were assumed that this is the case, the method employed furnishes an explanation of the fact that the surface wind is, on the average, roughly about half the gradient wind in the latitude of the British Isles.

Society of Public Analysts, December 1.—Mr. A. Chaston Chapman, president, in the chair.—W. **Partridge**: The "presumptive *coli* test" on unchilled water. The author points out that if positive results are ignored and negative results only considered, the "presumptive *B. coli* test" often usefully supplements the ordinary chemical analysis of unchilled water.—E. R. **Bolton**: Notes on methods of analysing oleaginous seeds and fruits. It is shown that the errors in the estimation of oil in oleaginous seeds and fruits (copra in particular) are due rather to "sampling" than to actual analysis. Methods of sampling, grinding, and analysis were demonstrated to show that, while the oil in copra could be estimated with great accuracy by the methods given, a departure from the procedure would be liable to cause considerable error.

MANCHESTER.

Literary and Philosophical Society, November 16.—Prof. S. J. Hickson, president, in the chair.—Dr. G. A. **Hemsalech**: The spectra emitted by metal vapours in the explosion region of the air-coal-gas flame. The author reviewed the work done on Bunsen-flame spectra by M. de Watteville, and on the different flame spectra of calcium and iron by Hemsalech and

de Watteville. He described a simple and convenient burner by means of which the various flame phenomena can be readily subjected to spectroscopic observation and experiment. Photographs were shown to illustrate the changes in the Swan spectrum emitted by the explosion region of flames on passing from rich to very weak gas mixtures. For very weak mixtures the ordinary Swan spectrum disappears, and another band spectrum develops. Some experiments were then shown to demonstrate the action of electric fields on the flames of weak gas mixtures charged with sodium vapour. The great sensitiveness of such flames in a longitudinal field was illustrated in several ways, and, in particular, it was shown that when the gas mixture had become so weak that in the absence of the electric field it would no longer ignite, it would do so immediately on the field being restored.

EDINBURGH.

Royal Society, November 15.—Dr. J. Horne, vice-president, in the chair.—Dr. H. **Drinkwater**: Preliminary notice of a family showing inherited abnormal segmentation of the digits of both hands. The chief anatomical peculiarities were:—(1) The index, middle, and little finger much reduced in length, the ring finger projecting far beyond the others; (2) radiography shows (*a*) that the hands belong to the minor brachydactylous type, with abortive but separate middle phalanx; (*b*) that the base of the proximal phalanx of the index finger was very oblique, instead of being at right angles to the length of the bone, a condition shown to be due to the interposition of an extra bone of triangular shape; (*c*) that there are frequently two bones in place of the normal single proximal phalanx in the middle finger, the extra one being in series with the extra bone in the index finger. The condition had been hereditary in the family for (at least) four generations, and was transmitted on Mendelian lines.—Prof. Cossar **Ewart** and Miss Dorothy **Mackenzie**: The moulting of the king penguin. By means of a beautiful and complete series of photographs taken by Miss Mackenzie at the Edinburgh Zoological Park, the whole succession of stages in the process of moulting was clearly demonstrated. Other connected peculiarities of feather growth were also described.

DUBLIN.

Royal Dublin Society, November 23.—Prof. W. Brown in the chair.—Prof. W. **Brown**: The subsidence of torsional oscillations and the fatigue of iron wires when subjected to the influence of alternating magnetic fields of frequencies up to 250 per second. In the subsidence of torsional oscillations and in the fatigue of iron wires under the influence of alternating magnetic fields it was found that the time taken to effect the maximum fatigue was inversely proportional to the frequency of the applied alternating magnetic field, and that the maximum value of the fatigue was the same for frequencies 50 to 250 per second. Increasing the frequency of the alternating magnetic field five times had very little effect on the subsidence of torsional oscillations.—P. E. **Belas** and Prof. M. **Hartog**: The path of a small permeable body moving with negligible acceleration in a bi-polar field. When a small pellet of paraffin wax containing iron dust is floated in glycerine in the vicinity of the poles of an electromagnet, certain curved paths are described by the pellet, which moves so as to include the maximum number of lines of induction. These paths were traced by focusing the image of the pellet on the ground glass of a camera fitted with a right-angled prism, and dotting in with a pencil the successive positions of the image. The curves were taken for similar and dissimilar poles.—T. G. **Mason**: Preliminary notes on the carbohydrates of the Musci. The wide divergence of opinion that prevails concerning the carbohydrates of the angiosperms has suggested that an investigation conducted among the Musci would be of interest, and might shed light on the subject of photosynthesis. Dextrose, levulose, and sucrose have been identified in the following species:—*Polytrichum commune*, *Sphagnum cymbifolium*, and *Thuidium tamariscinum*. Maltose was found in *P. commune* alone; it is found only when starch is present. Invertase was detected in *P. commune*, *T. tamariscinum*, *S. cymbifolium*, *Brachythecium rivulare*, and *Dicranus majus*. The distribution of diastase and maltase is dependent on the presence of starch. In *P. commune* and *S. cymbifolium* the hexoses are the chief form in which the carbohydrates are translocated from the leaves. In *S. cymbifolium* sucrose is the first sugar to be formed in appreciable quantities after the application of light.—J. J. **Dowling**: A new form of very high resistance for use with electrometers. To measure very small currents by a steady deflection method, using an electrometer, very large resistances are required. The equivalent to such a large resistance may be obtained by alternately charging and discharging a condenser, as in Siemen's method for measuring small capacities. Assuming that the electrometer system has a capacity large compared with the condenser (c farads), which is intermittently connected to it (n times per second), the potential (V), to which the electrometer system rises, when a current (i) is flowing in, is given by the equation $ncV=i$. The arrangement is thus equivalent to a resistance $R=1/nc$ ohms. Values of R up to 10^{10} ohms have been worked with, but greater values may be obtained. If the condenser is not simply discharged each time, but charged with the opposite sign, the method may be used as a "zero" or a "compensation" method.

PARIS.

Academy of Sciences, November 22.—M. Ed. Perrier in the chair.—L. **Maquenne**: The action of saccharose on the cupropotassic solution. In the action of alkaline copper solutions upon invert sugar, the reducing power is mainly dependent upon the proportion of alkali and only slightly affected by the proportion of copper. But with cane-sugar the reverse is the case; the action appears to be one of oxidation by the copper salt, and is not a result of hydrolysis by the alkali.—L. **Guignard**: New observations on the formation of pollen in certain Monocotyledons. In all the species of Iridaceæ examined the mode of division of the mother pollen cell resembles that typical in the Dicotyledons.—A. **Blondel** and F. **Carbenay**: The forced oscillations of an oscillating system with discontinuous damping.—P. **Carrasco**: The structure of the line spectrum of the solar corona. A photograph of the solar corona taken during the eclipse of August 21, 1914, gave a red line as the most prominent in the spectrum (λ 6374). It is now shown that this line is included in Nicholson's series, $\lambda=(18{\cdot}5397-1{\cdot}1029n)^3$, n having the values 0, 1, 2, 3, etc.—J. **Haag**: The calculation of time.—Gabriel **Sizes**: The resonance law of sonorous bodies.—L. **Tschugaeff** and L. **Tschernijaeff**: The complex hydroxylamine compounds of bivalent platinum. An account of the preparation of all the members of the series $Pt(NH_2.OH)_n(NH_3)_{4-n}X^2$, of which only the extremes, $Pt(NH_3)_4X_2$ and $Pt(NH_2.OH)_4X_2$ were previously known.—M. **Dalloni**: The upper Miocene in the west of Algeria; the Hipparion layers of Tafna.—P. W. **Stuart-Menteath**: The lignites of Bidart-Biarritz.—Louis **Lapicque**: New methods for electrodiagnosis.—Charles **Nicolle** and Ludovic **Blaizot**: New researches on exanthematic typhus. The virus can be preserved indefinitely by transmission through guinea-pigs. During the fever, the unknown micro-organism of typhus is present in all the organs of the body, even when free from blood.—E. **Vasticar**: The terminations of the acoustic nerve.—H. **Colin**: The sterilisation of

water by carbonic acid under pressure. Water containing the Eberth bacillus is sterilised by carbonic acid in 20 hours under 10 kg. pressure, 8 to 20 hours under 15 kg., 3 to 9 hours under 20 kg., and 3 to 6 hours under 25 kg. pressure. Data for other micro-organisms are also given.

BOOKS RECEIVED.

Mimicry in Butterflies. By Prof. R. C. Punnett. Pp. vi+188+plates xvi. (Cambridge: At the University Press.) 15s. net.

A Student's Book on Soils and Manures. By Dr. E. J. Russell. Pp. ix+206. (Cambridge: At the University Press.) 3s. 6d. net.

Soils and Plant Life as related to Agriculture. By Prof. J. C. Cunningham and W. H. Lancelot. Pp. xx+348. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 5s. net.

The Cambridge University Calendar for the Year 1915–1916. Pp. xxvi+1069. (Cambridge: At the University Press.) 7s. 6d. net.

A Course of Modern Analysis. By Prof. E. T. Whittaker and Prof. G. N. Watson. Second edition. Pp. 560. (Cambridge: At the University Press.) 18s. net.

U.S. Bureau of Education. Bulletin No. 27. Whole No. 654. Opportunities for Foreign Students at Colleges and Universities in the United States. Pp. 213. (Washington: Government Printing Office.)

Smithsonian Miscellaneous Collections. Vol. lxv., No. 3. Hodgkins Fund: A Study of the Radiation of the Atmosphere. By A. Angström. Pp. v+159. (Washington: Smithsonian Institution.)

Homer and History. By Dr. W. Leaf. Pp. xvi+375. (London: Macmillan and Co., Ltd.) 12s. net.

Instinct and Intelligence. By N. C. Macnamara. Pp. 216. (London: H. Frowde and Hodder and Stoughton.) 6s. net.

Contributions from the Jefferson Physical Laboratory of Harvard University for the Years 1913 and 1914. Vol. xi. (Cambridge, Mass.)

Department of Education, Ontario. Educational Pamphlets, No. 9: Laboratory Accommodation in Continuation and High Schools and Collegiate Institutes. By G. A. Cornish. Pp. viii+144. (Toronto: L. K. Cameron.)

DIARY OF SOCIETIES.

THURSDAY, DECEMBER 9.

ROYAL SOCIETY, at 4.30.—Croonian Lecture: The Respiratory Process in Muscle; and the Nature of Muscular Motion: Dr. W. M. Fletcher and Prof F G Hopkins.

MATHEMATICAL SOCIETY, at 5.30.—The Vibrations of a Special Type of Dissipative System: H. Jeffreys.—Diffraction by a Wedge: F. J. W. Whipple.—Some Applications of the Two-three Birational Space Transformation: T. L. Wren.—The Circles which Touch the Escribed Circles of a Triangle: T. C. Lewis.

OPTICAL SOCIETY, at 8.—Improvements in Prismatic Compasses, with Special Reference to the Creagh-Osborne Patent Compass: A Hughes.

FRIDAY, DECEMBER 10.

ROYAL ASTRONOMICAL SOCIETY, at 5.—(1) The Accuracy of Hagen's Chart of T Herculis, and on a possible new Variable Star; (2) Note on the number of faint stars with large Proper Motions: F. A. Bellamy.—The Theory of Star-streaming and the Structure of the Universe: J. H. Jeans.—(1) The Viscosity of the Earth, second paper; (2) The Figure of the Earth; a reply to Mr. Hinks: H. Jeffreys.—Note on Comet Mellish (1915*a*), 1915, October 4: F. Henroteau.—Preliminary Paper on recent lists of new Double Stars: E. Doolittle.—The Distribution of Stars in Globular Clusters: H. C. Plummer.—*Probable Papers:* The Magnitude Scales of the Astrographic Catalogue, ninth note: The Toulouse and Cape Magnitudes, with further remarks on the Obscured Regio in the Sky as a Spiral H. H. Turner.—Baxendell's Observations of Variable Stars, fifth instalment; No. 13, T Herculis and No. 14 R Leonis: H. H. Turner and Mary A. Blagg.

MALACOLOGICAL SOCIETY, at 7.—Note on the Oligocene of Tampa, Florida, the Panama Canal Zone, and the Antillean Region: Dr. W. H. Dall.—Description of Two New Species of Angasella: G. K. Gude.

MONDAY, DECEMBER 13.

ROYAL SOCIETY OF ARTS, at 4.30.—Optical Glass. III.: Dr. W. Rosenhain.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—The Work of the Peru-Bolivia Boundary Commission: Sir T. H. Holdich.

VICTORIA INSTITUTE, at 4.30.—The Movements of the Stars: Prof. A. S. Eddington.

SOCIETY OF ENGINEERS, at 5.30.—Annual General Meeting.

TUESDAY, DECEMBER 14.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 5.—The Evolution of the Earliest "Chelles" Palæoliths from the Rostro-Carinate Implements: J. Reid Moir.

INSTITUTION OF CIVIL ENGINEERS, at 5.30.—"James Forest" Lecture, Electrical Railways: H. M. Hobart.

ILLUMINATING ENGINEERING SOCIETY, at 8.—Recent Developments in Electric Incandescent Lamps in Relation to Illuminating Engineering: Prof. J. T. Morris.

WEDNESDAY, DECEMBER 15.

ROYAL SOCIETY OF ARTS, at 4.30.—Carillons and Carillon Playing: J. J. Denyn and W. W. Starmer.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—The Incidence of Bright Sunshine over the United Kingdom during the thirty years, 1881—1910: F. J. Brodie.—Remarkable Cloud Phenomena: Dr. W. Galloway.—South African Coast Temperatures: Dr. J. R. Sutton.

ROYAL MICROSCOPICAL SOCIETY, at 8.—The Use of Ultra-violet Light in Microscopy: J. E. Barnard.

GEOLOGICAL SOCIETY, at 5.30.—Deep-Boring for Coal at Little Africk, near Missenden (Bucks): Dr. A. Strahan.

THURSDAY, DECEMBER 16.

ROYAL SOCIETY OF ARTS, at 4.30.—The Indian Jute Industry: C. C. McLeod.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Design of High-pressure Distribution Systems: J. R. Beard.

ROYAL GEOGRAPHICAL SOCIETY, at 5.—The Nature and Formation of Sand Ripples and Dunes: W. J. Harding King.

LINNEAN SOCIETY, at 5.—The Structure and History of Play: The Floating Fen of the Delta of the Danube: Miss Marietta Pallis.—The Seed-mass and Dispersal of *Helleborus fœtidus*, Linn.: T. A. Dymes.—Sample of "Figured Ebony," with Specimens of Walking-sticks Manufactured from it by Messrs. Henry Howell & Co.: B. Daydon Jackson.—The Reproduction of Protodrilus; E. S. Goodrich.

FRIDAY, DECEMBER 17.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Engineering Colleges and the War: Dr. R. Mullineux Walmsley and C. E. Larard.

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THURSDAY, DECEMBER 16, 1915.

INDUSTRIAL RESEARCH LABORATORIES.

THE application of science to industry is a subject which the war has brought to the forefront in the most striking way possible; and it is beginning to be understood how essential to industrial development is scientific research, whether carried on purely with the motive of increasing natural knowledge, or in laboratories where financially profitable solutions of practical problems are the chief aims.

One of the most interesting characteristics of the development of industrial organisations during recent years has been the establishment of industrial research laboratories. A laboratory for the testing of the materials employed, and of the finished products of a manufacturing firm, is an essential part of every modern works. The newer laboratories, however, show that manufacturers are realising the necessity for scientific research in those branches of science with which their industry is most closely connected. They realise that it is not enough to ensure that the apparatus and machinery that is manufactured is up to standard, and to effect those minor improvements in detail which become evident from careful and systematic tests; but that it is necessary for the advancement of their work to carry out scientific investigations. A great deal can be said in favour of this work being done by central State institutions adequately equipped and provided with an efficient staff for carrying out such researches as may be desired by the manufacturers. Such laboratories exist at present in this and other countries.

The work of the National Physical Laboratory is known to all, and the value of what has been done in making tests and measurements on all kinds of material and apparatus is universally recognised. In America the Bureau of Standards is now established on a scale princely in comparison with our laboratory at Teddington. In Germany the "Reichsanstalt" and the "Versuchsanstalt," for investigating the properties of materials used in engineering structures, have proved of enormous value. The engineering and scientific laboratories of the universities and higher technical schools have also contributed no small share to the increase of our knowledge of facts essential to the advancement of industry.

In such investigations as those on the properties of materials, standardisation of specifications, and work of a character which necessitates strict impartiality as between different manufacturers, there is no doubt that State institutions provide the only practical method of doing what is required. For experiments on a large scale where it is necessary to use the manufacturing facilities of a large factory to the utmost, for example, in the development of new types of engine or of improved constructional work, it seems equally clear that the manufacturer is the only person who can undertake the research work that may be required effectively.

The war has already led to a more intimate association between the scientific worker and the manufacturer than has ever existed before in this country; a result which has been due very largely to the overwhelming evidence which Germany has provided of the effects such co-operation has been able to produce on her industries.

To carry out researches in a factory requires the service of scientifically trained men who will undertake investigations in a scientific way, and will co-ordinate the results with the least possible expenditure of time and energy. If time is to be saved by eliminating suggested improvements which are not based on sound scientific principles, it is essential that the work should be done by people who have a thorough groundwork of scientific knowledge. They need not necessarily be highly skilled in the technique of the process they are investigating, though a good knowledge of applied science is an invaluable asset to such an investigator.

Most manufacturers will acknowledge that it is to scientifically trained men working in well-equipped research laboratories that the greater part of industrial progress is due. Such men must be endowed with a critical scientific faculty and be able to avoid the pitfalls that trap the untrained inventor. In an article by Mr. Little in the *Journal of Industrial and Engineering Chemistry*, some facts are given about the progress of these laboratories in the United States. He cites the famous Edison laboratories as an example of what has been done in this direction. The Eastman Kodak Company has large laboratories for purely scientific investigations. The Du Pont Powder Company employs 250 trained chemists with laboratories spread over sixty acres of ground. But perhaps the most interesting example of what is being done in this direction by large firms in America is the research laboratory of the General Electric Company of Schenectady.

This laboratory started on quite a small scale about fourteen years ago. It now occupies a

seven-storey building with a staff of 150 researchers. It possesses a good library in which the chief scientific publications are available, an elaborately equipped workshop and experimental rooms for scientific investigations. A considerable portion of its work is connected with the testing of insulating material for electrical machinery. Other subjects of study are the mechanical and electrical properties of alloys both for magnetic and resistance work. Experimental investigations are undertaken in connection with incandescent lamps. The experiments made there were the basis of the new gas-filled tungsten lamp. The scientific groundwork of the processes of lamp manufacture in all its branches is thoroughly examined. One room is devoted to phenomena occurring in very high vacuum. The electron emission from a hot tungsten filament in a vacuum, so high that there is very little ionisation, has been studied and has been utilised in the Coolidge X-ray tube and in the development of a high voltage rectifier. Another branch of study is that of the high frequency phenomena which find their application in wireless telegraph transmission, and for this purpose a wireless antenna for experimental purposes has been erected. In an article by Mr. L. A. Hawkins describing the laboratory, he states that:—

"The laboratory is continuously conducting researches of a purely scientific nature and publishing the results, to endeavour to contribute its share to the progress of scientific thought. . . . These investigations may be initiated because of their scientific interest without any definite practical object in view, but . . . every marked advance in science sooner or later, directly or indirectly, has resulted in important effects on industry, and these laboratory investigations have certainly nearly always had practical results. . . . It should not be supposed, however, that all the important achievements of the laboratory have been thus brought about. Many of them were the result of persistent and resourceful effort directed from the beginning towards a perfectly definite goal. . . . Even in those cases where unforeseen practical results are made possible by the new insight into fundamentals, gained from purely scientific research, they seldom first appear in fully developed form, like Athena sprung from the brain of Zeus, but much work, inventive and experimental, is usually necessary before that end is reached."

It would be impossible to express more clearly than has been done in these paragraphs the point of view which scientific men have been urging for many years past, and it is a hopeful sign that those responsible for such a large industrial undertaking as the General Electric Company should have come to the conclusion that purely scientific investigation is one of the necessary conditions of progressive development, and should have acted so practically as a result of that belief.

The industrial conditions existing in this country hitherto have made it almost impossible to establish research laboratories in connection with many engineering works. Possibly this may have been due to a failure on the part of those concerned to recognise the importance of industrial research. Possibly, and more probably, it has been due to the financial conditions under which many British engineering firms have had to work, and to the insecurity of the markets which they have had to supply. If neglect of research is the true explanation of our backwardness, the excuse will hold no longer, as the war has proved, as nothing else could have done, what remarkable productive results may be obtained from a scientifically organised industry.

WIRELESS TELEGRAPHY AND TIME SIGNALS.

(1) *The Wireless Telegraphist's Pocket Book of Notes, Formulae, and Calculations.* By Prof. J. A. Fleming. Pp. xii + 347. (London: Wireless Press, Ltd., 1915.) Price 6*s.* net.

(2) *Wireless Time Signals: Radio-telegraphic Time and Weather Signals Transmitted from the Eiffel Tower, and their Reception.* Issued by the Paris Bureau of Longitudes. Pp. ix + 133. (London: E. and F. N. Spon, Ltd., 1915.) Price 3*s.* 6*d.* net.

(1) THIS book, though of more than three hundred pages, is of a size that can go into a moderately large pocket, and contains, in virtue of the clear and close printing, a large amount of information. To those who are familiar with Prof. Fleming's large treatise on electric-wave telegraphy the present volume may be briefly described by saying that it is for the main part a series of notes carefully selected from that work, together with matter from recent papers by the author, and with a number of mathematical tables.

In style and contents the book is a decided departure from other "pocket books" dealing with engineering subjects, for it is devoted rather to the abstract theory of its subject than to the workaday aspects. Moreover, many of the formulæ and equations are developed in full logical form, and not merely thrown down before the reader in their final shape, ready for practical applications.

The first chapter may be regarded as a summary of those parts of mathematics and mathematical physics which are applied to wireless telegraph problems in the author's larger treatise. There is a brief exposition of differential and integral calculus, of differential equations, of the theory of the Argand diagram, and of vector analysis, culminating in an explanation of the more mathematical aspects of divergence, curl, and vector potential, and in the derivation of Poisson's equation and Stokes's theorem. Later this theory is applied in the orthodox way to the formation of Maxwell's equations and to the solution in the standard manner of the Hertz oscillator problem. The second chapter is more physical than the first, and deals with the important subjects of units and dimensions.

Chapters iii. to vi. discuss the laboratory physics of wireless telegraphy, attention being paid especially to the derivation of the formulæ used in the electrical laboratory. For example, there is a good and fairly full account of the theory of certain bridge methods of measuring inductance and capacity. Chapters ix. and x. deal with the principles underlying the production of electric waves, and contain the principal formulæ for the radiation from antennæ. Similarly the next chapter, on the reception of signals, is devoted largely to principles, though containing some useful pages occupied with brief descriptions of various detectors. From the list of detectors the modern forms of the vacuum valve detector and relay are all missing, although these are playing so large a *rôle* in recent long-distance triumphs in wireless telegraphy and telephony. Chapter xi. begins the practical portion of the work. In it are given the Morse code, some hints on the management of storage cells, a couple of pages on the management of wireless telegraph apparatus, and a glossary of terms. Chapter xii. concludes the book with about fifty pages of the usual mathematical tables and eight pages of tables of physical constants. The mathematical tables are very beautifully printed, and contain some improvements designed to make reference rapid and easy.

The most permanent impression left by the book on the mind of the reviewer is that the author appears to entertain a very high opinion of the intellectual equipment of the wireless telegraphist and of his ambition to breathe the rarest atmosphere of the subject. In all probability the book will receive a warmer welcome from the advanced students of electro-technics in our colleges than from the class it is ostensibly written for.

(2) This little book is a translation of one issued two or three years ago by the Paris Bureau of Longitudes for enabling French nagivators, clockmakers, and others requiring accurate time, to make full use of the excellent series of radiotelegraphic time signals sent daily from the Eiffel Tower station. Since the Paris station is only one of a projected international chain of time stations, such a book as this is, or will be, useful in other countries.

The work begins with a clear description of the apparatus needed by a person who wishes to receive the time signals; several types of apparatus are, in fact, described, beginning with the very simplest and closing with a fairly elaborate plant. It will be difficult to find anywhere an explanation more helpful to the novice than this. Then follows an account of the kinds of time signals emitted from the Eiffel Tower, which include morning and evening sets of signals intended for navigators and horologists, and also scientific signals which give, by an application of the method of coincidences, the time accurate to about 1/100 second.

Of course, the war has put much of the work of the Eiffel station out of joint; for instance, the meteorological signals described in this book are not now transmitted as before, but no hint of this fact is given in the book, which, though dated 1915, speaks as if everything were proceeding normally everywhere. This failure to take account of the effects of the war on wireless telegraph matters appears even in the translators' appendices, in one of which it is stated that English weather reports are issued daily by the Admiralty from Whitehall and Cleethorpes. The writer of this review cannot affirm with finality that such reports are not issued; no private individual is now allowed to possess "wireless" apparatus to test the matter—but it is unlikely that meteorological reports are sent broadcast at this period. This fault is apparently the only fault of the work, and it is here pointed out for the sake of historical accuracy.

THE STEAM ENGINE.

Steam Power. By Prof. W. E. Dalby. Pp. xvi +760. (London: Edward Arnold, 1915.) 21*s*. net.

IN this volume we have the most complete, the most scientifically correct, and the most up-to-date treatment of the problem of the generation of steam and its utilisation for power purposes which has ever been put at the disposal of the engineer and the designer of power plants.

Although Sir J. A. Ewing in the latest edition

of his book on the steam engine had accepted the characteristic equation of Callendar and had utilised the steam tables derived from it by Mollier, and had thus directed the attention of the British engineering world to Callendar's researches, it is to be feared that the majority of our engineers were still ignorant of and oblivious to the epoch-making character of Prof. Callendar's researches and his work in the field of thermodynamics.

Prof. Dalby has made it impossible for anyone in the future to ignore these researches. In chapter iii., on the motive-power circuit-thermodynamics, in sections 47 to 49 Callendar's characteristic equation of steam is dealt with in a clear and concise fashion; and the whole of the steam tables in the appendix have been calculated by Prof. Callendar himself from the expressions given in this chapter. In chapter iv. the sections dealing with the so-called "missing quantity" are practically based upon the researches of Callendar and Nicolson (by a slip in the preface an account of these researches is stated to be incorporated in chapter v.), and lastly Prof. Callendar's work on the theory of the flow of steam through nozzles is made free use of in chapter xi., which deals with this important branch of the subject, of such vital importance in the design of steam turbines. We have indicated enough to show how largely the author has drawn upon the rich stores of theory and experimental results which Prof. Callendar has placed in recent years at the disposal of engineers.

Following Sir J. A. Ewing, the author has abandoned the Fahrenheit and adopted the Centigrade scale; modern research is always expressed in terms of this latter scale, and it is certainly high time that British and American engineers discarded for ever the Fahrenheit scale, which introduces needless complications, and has nothing to commend it; for commercial reasons alone it would be a great advantage to engine-builders and others to come into line with the rest of the world and to adopt the Centigrade scale. It may be a difficult matter to introduce in its entirety the metric system, though we have little doubt that sooner or later such a change must be made, but it would surely be an easy matter to pass an Act enforcing the use, after a given interval of time, of the Centigrade thermometer and making it illegal to manufacture any longer Fahrenheit thermometers. The Meteorological Department has recently made a valuable step forward in deciding that in future rainfall records shall be given in millimetres. Why not go a step further and publish all their temperature records in the Centigrade scale? Were the Department to take this step the public would soon fall into line, and in a short time everyone would as readily think in Centigrade units as they do now in Fahrenheit units. We warmly congratulate the author for the decision he came to in this matter; for the time being it is necessary, if we use the Centigrade scale, to adopt a somewhat unusual heat unit—the lb.-calorie, but such a unit is inevitable so long as we retain the pound as the unit of weight.

Prof. Dalby has for some time been in the front rank of those workers who have specialised in that section of thermodynamics which deals with the problem of the steam locomotive, and he has drawn freely upon his published researches for much of the matter contained in chapter viii., which deals with the motion of a train and the rate at which energy must be spent to produce, to maintain, and to destroy it. This chapter will prove invaluable to the designers of locomotives; it is largely the result of original work, and the problems to be solved have been attacked in a strikingly novel manner. The validity of the author's methods has been confirmed by examination of the published results of elaborate tests of the performances of locomotives carried out in the United States. It is well known that Prof. Dalby has organised a highly successful post-graduate course in railway engineering at the Imperial College of Science, South Kensington, and this chapter is a striking testimony to the thoroughness with which he is attacking the problems which will have to be faced if any radical improvement in the thermal efficiency of the steam locomotive is to be obtained in the near future.

Two other chapters which will be specially useful to the drawing office are those dealing with the balancing of engines, and valves and valve-gear diagrams, treated, of course, in a more condensed fashion than in the author's well-known text-books on these two branches of engine design, but still in a sufficiently full and complete form for the engineer who aims at acquiring a sound knowledge of the principles upon which the successful design of engines must be based.

The last chapter deals with steam turbines, and we think Prof. Dalby has in this chapter produced the best account we have ever read of this class of steam generators, both from the point of theory and of actual design, and it says much for his methods that he has been able to do this in some seventy-five pages.

If we have any criticism to offer on this book, it is in the form of a suggestion that in any reissue the book should be broken up into two volumes. The present volume contains 760 pp.,

and is really too cumbersome and heavy for convenient use. If chapters i. to vi. and chapter xi. formed one volume, with the steam tables as an appendix, the other chapters would fit well into a second volume.

In conclusion, we offer our warm congratulations to the author. He has achieved a great task; this book is a testimony to his powers as an original worker, and to the wide grasp he has obtained of the whole field of work covered by it. We would commend a careful study of the book to those, only too numerous, detractors of the work achieved by British men of science and practical engineers. They will find ample testimony that in this field of human activity the British workers easily hold a foremost place.

T. H. B.

MATHEMATICAL TEXT-BOOKS.

(1) *Plane Geometry*. By G. St. L. Carson and Prof. D. E. Smith. Part i., pp. vi+266. Part ii., pp. vi+259–482. (London and Boston: Ginn and Co., 1914–15.) Price 2*s*. 6*d*. each part.

(2) *Elements of Algebra*. By G. St. L. Carson and Prof. D. E. Smith. Part ii., pp. v+538. (London and Boston: Ginn and Co., 1915.) Price 2*s*. 6*d*.

(3) *Contributions to the Founding of the Theory of Transfinite Numbers*. By G. Cantor. Translated by P. E. B. Jourdain. Pp. ix+211. (Chicago and London: The Open Court Publishing Co., 1915.) Price 3*s*. 6*d*. net.

(4) *A Text-book on Practical Mathematics for Advanced Technical Students*. By H. L. Mann, Pp. xii+487. (London: Longmans, Green and Co., 1915.) Price 7*s*. 6*d*. net.

(5) *Descriptive Geometry*. By H. W. Miller. 3rd edition. Pp. 149. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1915.) Price 6*s*. 6*d*. net.

(1) MANY attempts are now being made to formulate a system of geometry suitable to the immature minds of schoolboys, which will on one hand develop their reasoning faculties by some kind of logical training, and on the other by a sufficiency of practical work clarify their ideas as to the concepts which form the basis of the subject.

It is unfortunately true that as yet no general agreement has been obtained, or any course determined which is not open to formidable attacks from one school of thought or another. Time alone will bring about consensus of opinion in a controversy that has raged since the time when Lewis Carroll wrote his "Euclid and his Modern Rivals"; and educational opinion will gradually solidify by the action of those teachers and writers who are attempting to express the results of their personal experience.

If for no other reason, we hope that this volume will receive the serious consideration it merits; for it offers, not indeed a final, but certainly a valuable contribution to these issues. It would be beyond the scope of this notice to examine in any detail the course followed; and it is detailed examination alone that justifies the passing of any judgment. The authors have had extensive experience in the matters of which they write, and the views they have formed are the product of a genuine knowledge of the needs and capacities of junior students and of those psychological considerations to which educationists are now attaching due importance.

(2) The first part of this text-book has already been noticed in these columns; the second part, written on similar lines, carries the student as far as progressions and the binomial theorem for a positive integral index. We notice with regret that the section on graphs includes the tracing of the ellipse $4x^2+9y^2=288$; such work should, in our opinion, be relegated to co-ordinate geometry proper; we think also that examples on the greatest term in a binomial expansion, although sanctioned by tradition, might well be omitted from the ordinary algebra course. But, except for a few minor points such as these, the character of the book appears to us excellent, and we shall expect to see it hold its own in the strenuous competition that every text-book on elementary algebra has now to face.

(3) This volume contains the two classical memoirs on transfinite cardinal and ordinal numbers which Prof. Cantor contributed to the *Mathematische Annalen* in 1895 and 1897. They are prefaced by a long introduction (more than 80 pages) by Mr. Jourdain, in which he traces the growth of the theory of functions through the nineteenth century, with special reference to the work of Cantor and Weierstrass; the concluding pages of the book contain some notes on modern developments.

This introduction will undoubtedly prove of great value to English students and teachers; its admirable summary of the progress of ideas will smooth their pathway and assist and encourage them to study that modern work to which the author has himself already furnished substantial contributions.

(4) Although the first few chapters are devoted to such algebra, trigonometry and geometry as technical students are likely to require, the main purpose of this book is to provide a suitable

calculus course for engineers. The preliminary work appears to have been selected solely with this end in view.

It is rather a formidable-looking volume, containing nearly 500 pages; and it would be more readable if there was some variation in the type (in itself very good) employed. There are many signs of individuality in the methods of treatment and in the choice of subject-matter; the examples are particularly stimulating, and on this account alone teachers would do well to examine it. The sections on periodic functions and harmonic analysis deserve a special word of praise.

(5) This small text-book contains in a compact form the elements of practical drawing. The author writes from the point of view of one who has realised from industrial work the importance of accuracy in the workshops, and he insists throughout on the need of close attention to conventional notation and lucidity of expression. His diagrams are clear, and his explanations are couched in simple language.

For most students descriptive geometry is not an easy subject; it requires a power of visualising, which comes only after long perseverance and practice. Such a book as this seems to us to give as much assistance to the student as he can receive from outside; a grasp of the subject can only be obtained by his own diligence.

OUR BOOKSHELF.

La Radiologie de Guerre. Manuel Pratique du Manipulateur Radiologiste. By G. Massiot and Biquard. Pp. viii+224. (Paris: A. Maloine et Fils, 1915.) Price 3.50 francs.

A NEW impulse has been given by the war to those who desire to say over again what has been often and well set out already in text-books dealing with the practical applications of X-rays. Nevertheless, it must be admitted that extraordinary inventive effort has been called for of late regarding the design of new apparatus to meet special and unusual conditions; and, in so far as a new book on the subject deals conscientiously with this fresh phase, it should prove useful in practice.

The work under review suffers somewhat from the defect that the authors are concerned with the appliances designed and made by one firm only. But if in one respect the book has the limitations of an elaborated trade catalogue, it also has the great merit of clearness and simplicity. It contains a large amount of general information relating to X-ray technique which should not only be invaluable to the beginner, but serve also as a guide to all who have to organise X-ray departments for war purposes. For instance, the device for the wet racking of plates described on page 136, at first sight a small matter, assumes importance when many negatives have to be developed and examined rapidly. The effectiveness of the method recommended has, in fact, been proved at one of the military hospitals in this country, where it has been adopted since the outbreak of war and where sometimes 200 plates have to be dealt with in a day.

The book is full of useful detail of this sort, and more than one hundred pages are devoted to the question of the localisation of imbedded foreign bodies. The whole elementary ground of practical radiography is fairly covered, although no mention is made of stomach examinations and the technique of what may be called the "higher X-ray diagnosis." There are illustrations of folding couches, portable X-ray outfits, and so on, as well as ambulances that are complete radiographic departments on wheels.

Within the limits stated in the early part of this notice the book may be thoroughly recommended. C. E. S. P.

Laboratory Manual of Horticulture. By Prof. G. W. Hood. Pp. vi+234. (Boston and London: Ginn and Co., 1915.) Price 4s. 6d.

A COURSE in horticulture is by no means easy to devise, but it is certain that so far as the craft of the horticulturist is concerned the best place to learn it is in the garden, the potting-shed, and the frame-yard: these must constitute the laboratory. Hand-in-hand with training there should go work in botany, especially in vegetable physiology, in elementary chemistry, and physics, with the double object of inculcating scientific method (which should not be ignored in the garden) and of education in a knowledge of how plants grow.

Judged by this standard this "Laboratory Manual of Horticulture" falls lamentably short. It consists largely of observations on buds, corms, and fruits, and of experimental exercises with seeds, all of which fall into the realm of horticultural botany, and of exercises on making cuttings, grafts, buds, grafting-wax, fungicides and insecticides. It is intended as a general course in horticulture, but is really a series of exercises which have a more or less direct bearing upon practical plant-growing. It is true that it is recommended that after fundamental principles are mastered practice should be given in pruning and spraying, but even if this is done, a course which does not include tillage operations, potting, seed-sowing, planting, propagation (apart from the mere making of cuttings, etc.), watering, heating, ventilation, pollination, etc., cannot properly be called a course in horticulture.

After all, it is mainly with the title that we quarrel. The book cannot fail to prove suggestive to the teacher, or the working of the exercises profitable to the taught. The exercises are interleaved with blank pages for the student's notes and report, but we do not quite like the temptation to "copy" which the illustrations afford when directions are given to draw something. F. J. C.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Pre-Columbian Representations of the Elephant in America.

WHEN I wrote my letter on this subject to NATURE (November 25, p. 340) I was not aware of the fact that another interpretation of the Copan elephants was being seriously adopted in America. The admission of the proboscidean nature of the sculptures in question would place those who indulge in speculations as to the wholly indigenous origin and local evolution of the pre-Columbian civilisation of America in so critical a dilemma that from time to time efforts have been made to discredit the obvious view of regarding them as elephants. In my previous letter I directed attention to the attempts which had been made to convert them into tapirs or tortoises. Certain American ethnologists are now suggesting that the Copan reliefs in question were really intended to represent *blue macaws!*

Ludicrous as this suggestion (Parry, 1893; Gordon, 1909; Tozzer and Allen, 1910; and Spinden, "A Study of Maya Art," Memoirs of the Peabody Museum, 1913, p. 79) may seem to those who examine the features of the unmistakable elephant, which I reproduced in my previous letter, the arguments in support of it are not nearly so lacking in cogency as those with which I have already dealt.

For if the macaw-hypothesis were admitted, it would help to explain the positions of the nostril and eye, the origin of the geometrical pattern around the eye, and, in a vague manner, the presence and form of the trunk (see Gordon, Putnam Anniversary Volume, 1909, pp. 193–95). At Copan there is a beautifully modelled and very realistic representation of the macaw. But the very excellence of the portrayal of the macaw is an argument against the contention that the proboscidean animals can also be meant to be pictures of that bird, even in a conventionalised and extremely modified form. When the American artists set about conventionalising natural objects, an occupation at which they were past-masters, their methods were vastly different from those which such a hypothesis demands. Moreover, the accurate representation of the Indian elephant's profile, its trunk, tusk, and lower lip, the form of its ear, as well as the turbaned rider and his implement, no less than the distinctively Hindu artistic feeling in the modelling, are entirely fatal to the macaw-hypothesis.

The representation of a man sitting upon the head is as wholly inappropriate if the beast of burden is a macaw, as it would be in the case of a tapir or a tortoise.

Nevertheless, this suggestion has served to direct attention to points of special interest and importance, viz., the striking influence exerted by the representation of a well-known creature, the macaw, on the craftsmen who were set the task of modelling the elephant, which to them was an alien and wholly unknown animal. It explains how, in the case of the latter, the sculptor came to mistake the eye for the nostril and the auditory meatus for the eye, and also to employ a particular geometrical design for filling in the area of the auditory pinna.

In a memoir now in course of preparation I have discussed more fully the extensive literature relating to this elephant-controversy, and considered the problems arising out of it. In particular I have directed attention to a most remarkable confirmation of the identification of these American elephants. The series of beliefs which the ancient population of Mexico associated with Tlaloc, their elephant-headed god of rain, thunder, lightning, and agriculture (and the people of Yucatan with the proboscidean Chac), reproduce with the most amazing exactness the essential elements of the Hindu legends concerning Indra, the god of rain, thunder, and lightning, who was also associated with the elephant. Both were associated with the east and with the tops of mountains. Indra's most famous exploit was the slaying of "the snake Vritra, the restrainer, who catches and keeps in the clouds the rain that is falling to earth" (Hopkins, "The Religions of India," 1902, p. 94). Tlaloc is credited with similar performances (Joyce, "Mexican Archæology," 1914, p. 37). In the Codex Tro-Cortesianus Tlaloc is represented treading upon the head of a serpent who is interposed between the rain the god is pouring upon the earth (*Zeitsch f. Ethnologie*, 1910, p. 75, Fig. 837—in my previous letter I wrote "*Archiv*" instead of "*Zeitsch.*"). In the Codex Cortes (*op. cit.*, Fig. 839) the snake is shown coiled to surround and retain the water.

Coincidences of so remarkable a nature cannot be due to chance. They not only confirm the identification of the elephant-designs in America, but also incidentally point to the conclusion that the Hindu god Indra was adopted in Central America with practically all the attributes assigned to him in his Asiatic home.

G. ELLIOT SMITH.

The University of Manchester, December 3.

Electric Conductivity of the Atmosphere.

ONE of the Notes in NATURE of November 25 (p. 351) begins with the following sentence:—"The theory that the upper layers of the atmosphere are ionised and therefore conduct electricity, first enunciated by the late Prof. FitzGerald in 1893, . . ." It is a good rule, to which I have always hitherto adhered, not to raise questions of priority, but in this particular case a point of general interest in scientific history is involved, and a claim made which postpones the enunciation of a fruitful idea by six years. In the paper presented to the Royal Society in May, 1887 (Proc. Roy. Soc., vol. xlii., p. 371), I proved by experiment that the gas in a vessel through which an electric discharge passed became a conductor even in regions of the vessel remote from the discharge, and at the end of the paper the application of this result to the conductivity of the regions of the atmosphere affected by thunderstorms and auroræ is quite clearly expressed.

On first reading the paragraph in NATURE, I thought that the writer wished to lay stress on the word "ionisation," an expression I avoided for reasons which I need not enter into here, but on referring to FitzGerald's Collected Papers I find that in the only paper dated 1893 which deals with the subject the word is not made use of, and further, that the author does not claim any novelty for the idea, but refers to the conductivity of the atmosphere as an established fact. The term "ionisation" was first used by Arrhenius in describing experiments similar to mine, made independently but published somewhat later.

To avoid misunderstandings, I may add that in all the experiments above referred to the carriers of electricity, or "ions," as we should now call them, were considered to have molecular dimensions, as in the case of electrolytes. The idea of "corpuscles" of much smaller masses, afterwards introduced with such important results by Sir Joseph Thomson, belongs to a different chapter of the history of the subject.

ARTHUR SCHUSTER.

Yeldall, Twyford, Berks, November 29.

Viscosity of Cobbler's Wax.

FOR slowly damping a vibrating instrument of importance to the Navy, I let a metal knife cut through cobbler's wax, which is just soft enough to be squeezable between the fingers. The actual softness or hardness of the wax does not greatly matter, but what does matter is its becoming very much softer when its temperature increases from 15° C. to 30° C. This is its defect. I write in the hope that some one of your readers may be able to tell me of a suitable substance which will vary less in its softness as its temperature changes.

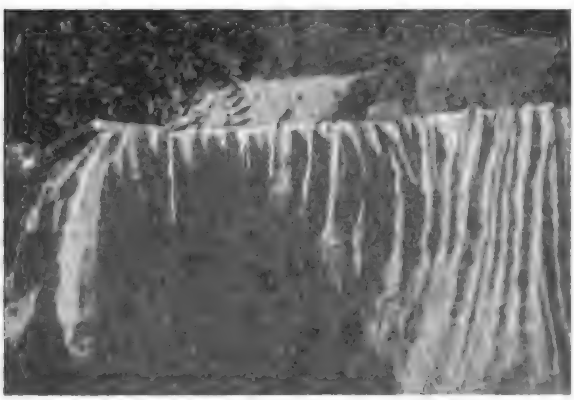
JOHN PERRY.

25 Stanley Crescent, Notting Hill, W., December 9.

The Cause of Fluted Weathering.

HAS the cause of fluted weathering, I would like to ask, ever been determined? It differs widely from all other forms of weathering that I have seen or read of. The long, smooth, parallel grooves are met with sometimes on the two sides of a block of limestone when such lies so that there are roof-like surfaces uppermost. On these two sides they frequently correspond at the ridge and follow a direct course downwards unless compelled to curve round some projecting boss.

The grooves may be 3 ft. long and of about equal



Fluted weathering in limestone, Italy. ×⅛.

width and depth along their whole course. The only specimen known to me in English museums is in the Oxford University Museum, which was got by Prof. W. J. Sollas from the Gemmi pass. I have seen good examples in the Jurassic limestone of Liguria, especially on the west of Finalmarina. Behind Pietra, on the left of the footpath to Ranza, the block, shown in this illustration, with several others, were seen. They were under olive trees, but it seemed impossible for such fluting to be produced by drip, and I wonder whether it could be the result of heavy dews or to some zoning influence.

G. ABBOTT.

2 Rusthall Park, Tunbridge Wells, December 4.

Winter Thunderstorms.

THOSE of your readers who may observe thunderstorms in the British Isles during the winter months would give great assistance to an investigation of thunderstorms on which I am engaged if they would report by postcard when they observe lightning or thunder during this winter. When sheet lightning is observed at night the time and direction should be given, and a note as to whether many flashes were seen or whether there were only two or three. When thunder is heard the time should be given, and the direction of the storm; it should also be stated whether lightning was seen and whether rain occurred. Much useful information might be gained from winter storms, but as thunderstorms may be very local they may sometimes be missed by the official observers; I should therefore gladly welcome help from anyone who is good enough to send me information. It is obvious that only winter storms can be dealt with in this way; I would therefore ask those who are willing to help to send information up to March 31st only.

CHARLES J. P. CAVE.

Meteorological Office, South Farnborough, Hants, December 9.

The Quadrantid Meteors.

THE ensuing display of these meteors occurs in the absence of moonlight. If the maximum continues to be at about the same position of the earth's orbit as formerly it will be in the early evening of January 3, which would be a convenient time for observation, although the radiant point is comparatively low then, the morning displays being the best.

T. W. BACKHOUSE.

West Hendon House, Sunderland, December 6.

LABORATORY ELECTRIC FURNACES.

MANY of the modern methods of chemical analysis involve the use of furnaces for the prolonged heating of materials; for example, the determination of carbon in steel, the carrying out of sealed-tube operations, etc., may be cited. Until recently, gas furnaces have almost exclusively been used for such purposes, but it seems probable that these will be largely replaced, in the future, by the improved types of electric furnace which are now obtainable. The electric furnace offers many advantages over the gas furnace, particularly in cases where it is desirable to maintain a constant temperature for any length of time.

The introduction of the comparatively new high resistance alloys of small temperature-coefficient has greatly simplified the construction and working of wire-wound furnaces. Such a furnace consists in its essential details of a tube of refractory material such as fireclay, alundum, or silica, upon which is wound a suitable length of the wire or strip; the tube is then supported in a case, the intervening space being filled with a material of low thermal conductivity, magnesia, for example. To ensure a long life and satisfactory running, attention must be paid to certain constructional details. The principal of these are:—(1) That the wire employed is as thick as possible, consistent with the dimensions of the tube and the voltage of the supply on which it is intended to be used; (2) that the wire is effectively protected from oxidation by preventing the access of air, the winding being for this purpose surrounded by a layer of powdered quartz or other suitable material; and (3) that the furnace is designed for and worked at the lowest voltage convenient.

In deciding upon the amount of lagging necessary, the purpose for which the furnace is to be employed must be considered. The provision of

thick and efficient lagging makes the furnace economical in that a comparatively small amount of energy is required to maintain it at any definite temperature; it, however, renders the furnace very sluggish, and for some operations this is a disadvantage. The ability to change the temperature rapidly and to adjust the new temperature quickly to a definite and constant value is a factor which frequently outweighs any small advantage accruing from a low power consumption.

We may consider for a moment the question of the power consumption of an electric furnace. A reasonably well-lagged furnace, with a tube, say, 1 in. internal diameter and 24 in. long, heated to the full temperature of 1000° C. over the central 18 to 20 in. of its length, should consume power at the rate of about 400 to 500 watts. This refers to the furnace itself, and it must be borne in mind that there is always an unavoidable amount of energy lost in the regulating resistance used in series with the electric furnace. This will

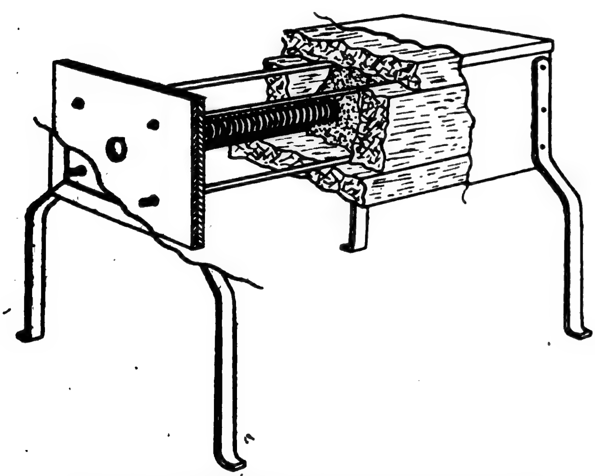


FIG. 1.—Sectional diagram of Messrs. Gallenkamp's furnace.

frequently amount to more than 50 per cent. of that usefully consumed in the furnace, and the loss cannot be overcome if provision is to be made for a fairly wide range of furnace temperatures. The external loss may be reduced for furnaces always run at a definite temperature; as in this case the winding may be so chosen to require only a small external resistance or even to dispense with it altogether. The latter procedure is not generally to be recommended owing to the lack of control thereby introduced.

If it be desired to maintain the temperature of a furnace constant to within about 20° C., it will often be found that the voltage of the commercial power circuit is not sufficiently steady for the purpose. A fluctuation of 5 per cent. in the voltage is not unusual, and the energy, and consequently the temperature, changes are thus of the order of 10 per cent. Rapid variations above and below a mean value are not of great importance, as the effect of these is damped out by the lag of the furnace. The intermittent use of large motors, etc., on the same energy distribution system is, however, a frequent source of trouble. The most accurate temperature control can be obtained by running the furnace off a large capacity storage battery.

To assist in the control of an electric furnace, it is always desirable to include an ammeter in the supply circuit. For a furnace wound with a low temperature-coefficient alloy, such as "nichrome," the current readings alone form a useful indication to the behaviour of the furnace, as the resistance does not change to any very great extent. In the case, however, of a platinum or nickel wound furnace this is not sufficient, and the volt-drop across the furnace must also be measured. It will frequently be found that changes in the regulating resistance in series with a platinum furnace produce no marked changes in the current, the volt-drop on the furnace, however, being considerably affected. The use of a wattmeter is hence to be recommended for furnaces wound with materials the temperature-coefficient of resistance of which is high.

In the construction of some furnaces use is made of various fireclay cements to hold the wind-

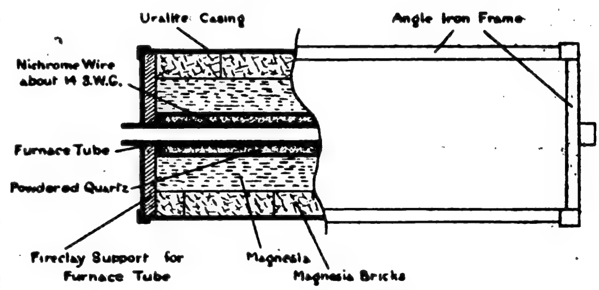


FIG. 2.—Diagrammatic representation of a typical wire-wound electric furnace.

ing in position on the tube. Except for furnaces which are not intended to run above 900° or 1000° C. this is undesirable, and a more satisfactory plan is to employ a tube on the external surface of which a spiral groove is moulded; such tubes may now be obtained in a variety of sizes from the leading makers of refractory materials. The ends of the winding should be held firmly in position by being bound with a few extra turns of the same material. At each end of the tube these wires, when tightly twisted together, will form multiple stranded leads serving for the current supply. The use of a different metal in contact with the winding is generally unsatisfactory, and the failure of a high temperature furnace is often due to this fault in construction. Another cause of failure which may be overlooked is the presence of a small piece of foreign matter or impurity in the lagging employed. If this comes into contact with the hot winding, it sometimes leads to fluxing of the wire and consequent breakdown of the furnace. The material used for lagging should hence be carefully examined, and, needless to say, it must be of such a nature that it will not react chemically

with the winding, even after long exposure at high temperature.

Some electric furnaces, embodying many of the points above referred to, have recently been put on the market by Messrs. A. Gallenkamp and Co., Ltd., London, and in the several designs available the needs of the chemist have been fully considered. The construction of a single-tube furnace is shown in Fig. 1. The lagging is provided by four slabs of a mixture of magnesia and asbestos, while the central space surrounding the wound tube is filled with powdered quartz. Electric furnaces for research work, and particularly for use at high temperatures up to 2500° C., may be obtained from Mr. Chas. W. Cook, of Manchester. He also lists a simple type of wire-wound combustion furnace for fixing on an ordinary retort stand. A similar furnace is supplied by Messrs. Baird and Tatlock, London, and should prove useful for many chemical operations.

OILS AND FATS.

CHEMICAL industry in Britain is now passing through a very critical period; many people are realising its importance, and it is being compared, not always to its advantage, with the German chemical industry. Whilst it is true that as regards the manufacture of dyes and pharmaceutical chemicals we have much leeway to make up, the same cannot be affirmed of all branches, even of the organic chemical industry. It is desired here to indicate briefly the present position of the oil and fat industry in relation to the application of science in it.

One illustration of the backwardness of applied chemistry in Britain which is often quoted by the would-be reformer is the lack of adequate text-books in English. In the great industry of oils and fats this reproach is certainly not justified; indeed, in Lewkowitsch's work[1] the industry possesses a text-book which is second to none, and has been translated more than once. Moreover, a challenge can be issued on behalf of this industry as one in which British foresight and enterprise have led the world. Whilst this success is in part due to the financial genius and organising ability of the founders of our great concerns, it is none the less principally based on the application of science, and probably in no other British industry has chemistry had such scope as in that connected with fats and oils. There is, perhaps, no better illustration of the chasm between the college and the factory, the existence of which was deplored by Dr. Forster at the annual meeting of the Society of Chemical Industry. The college has no idea of the knowledge of fats and oils possessed by the industry; writing with inside knowledge, this may be declared to be at least a decade ahead of the published literature. The colleges know not even the names of their industrial colleagues, or at least, like the proverbial prophets, these are without honour in chemical circles at home.

The third volume of Dr. Lewkowitsch's classic work gives a very complete summary of the technology of manufactured oils and fats, and even the most eminent expert will be certain to learn from almost any of its chapters. Unfortunately but a tithe of the knowledge which the writer really possessed of the actual working of the industry is recorded in its pages, doubtless because much of it had been acquired in confidence. As a consequence this, like other similar works, gives but an imperfect idea of the actual stage of development to which the industry has attained, and is to that extent disappointing when the manufacturer of to-day turns to it to help him out of his difficulties. All will agree, however, that Lewkowitsch's book is an integral part of the oil and fat industry, which his whole-hearted zeal and hard work did so much to advance, and that his all too early decease was a great misfortune.

The raw materials of the fat and oil industry are strikingly varied. At first limited in number, their scarcity and the consequent increase in value as the demand for soap and margarine grew have prompted a world-wide search to increase them, and chemical science has played an essential *rôle* in their development. Thus in early days soap was made in small works from tallow of local origin. As the works grew larger, tallow was imported to Europe from the large cattle and sheep raising districts in the New World. At the same time vegetable oils from the tropical countries began to be used for soap-making, and since the margarine industry also has learnt how to utilise such vegetable fats, the whole world has been laid under contribution to supply them. As most are the products of trees, their cultivation on any scale has not yet been successful, the exceptions being the oils from linseed, which is grown in temperate climates, and the soy bean of the East. Linseed oil is too unsaturated either for use in margarine or soap, but as a drying oil it has no equal. Until the discovery of the hardening process for saturating fats, the highly unsaturated whale oil and fish oils were of very limited application.

The manufacture of soap, an operation of great antiquity, is based on the simplest of chemical reactions, and even to-day in some countries it is carried out in a most primitive manner. This is in striking contrast to the up-to-date methods of the great British soap manufacturers, who have learnt how to make their soaps neutral so as to be without action on the skin or the most delicate fabrics; how to blend the fats which compose them so as to make soaps having any desired qualities; and even how to make the fullest use of the advance of physical chemistry, including such apparently academic branches as the phase rule.

Soap primarily requires a hard fat for its raw material; and with the margarine industry making the same request, the demand outstripped the supply. The situation might have become serious

[1] "Chemical Technology and Analysis of Oils, Fats, and Waxes." By Dr. J. Lewkowitsch. Edited by P. H. Warburton. Fifth edition. Vol. iii. Pp. viii+483. (London: Macmillan and Co., Ltd., 1915.) Price 25s. net.

from the point of view of the price of the raw materials if the success of the hardening process had not made the softer, unsaturated oils also available.

Few, if any, developments of recent years have been more remarkable and more truly chemical than that connected with the so-called hardening of fats—the realisation on an industrial scale of that very simple exercise in organic chemistry, the reduction of an unsaturated double bond by means of hydrogen. How simple it seems, and yet the leading expert on the chemistry of fats said not many years ago that it could not be done. Even Sabatier, the discoverer of the efficacy of metallic catalysts in the hydrogenation of vapours, expressly stated that his process failed with liquids. Normann's first patent for the hydrogenation of liquid fats was based, as all experimental work must be, on work done in the laboratory; there he was successful, and though his patent was crudely drawn—and who would have done better?—the great idea was there. Yet the successful application on the large scale took many years of arduous work and much capital expenditure. The German firm, Leprince and Sievke, who first bought Normann's process, made little of it, and parted with it to Joseph Crosfield and Sons, of Warrington, in whose hands it has been brought to its present success. The innumerable patents on the subject are little more than variations of the original idea of Normann—acts of piracy, for the most part, arising out of the present unsatisfactory condition of the patent laws. Yet a perusal of the most recent book on hydrogenation leaves the reader almost ignorant of the existence of the Warrington firm.

Not so many years ago glycerine was an almost worthless bye-product of the soap industry, and the spent lyes from the soap-pan were originally concentrated for the sake of the salt they contained. To-day the lyes are purified with the utmost care, and the glycerine is concentrated, distilled, and refined until the article sold is of quite remarkable purity considering its low price. The practical problem—one of chemical engineering—is to evaporate water from the dilute lyes until a crude glycerine is obtained at the cheapest possible cost. The contrast between the original shallow open pans heated by a fire and the elaborate multiple-effect vacuum evaporators with salting arrangements which are used to-day is a striking one. It is typical of the advances made in chemical engineering, a branch of the chemical profession which is as important industrially as that of the laboratory worker.

The stearine candle industry has lost ground owing to the powerful competition of gas and electricity in towns and the development in the use of cheaper paraffin, but it is still of importance both in England and abroad. The old empirical methods of preparing and blending the raw materials have given way to modern processes based on the knowledge of the chemical properties of the substances concerned.

Equally important as chemical achievements must rank the great developments in the processes of refining oils so as to render vegetable oils in particular available for edible purposes. This branch of the subject was described at some length in NATURE of April 8 (vol. xcv., p. 145).

Space forbids more than brief reference to the industries concerned with lubricating oils or with boiled oils for making varnishes and paints. The latter are almost wholly concerned with linseed oil, and their problems are connected with oxidising and changing the oils.

The outlook for the future in these industries in Britain may be faced with confidence. The tendency to aggregate the production in large factories enables a competent staff of chemists to be employed, and avoids the pitfalls consequent in the practice of rule-of-thumb methods in small concerns. Competition ensures the constant striving to invent and develop new and cheaper processes, and at the same time safeguards the public interests by providing them with a cheap article, the low price at which fat and oil products are retailed at the present day being one of the most remarkable testimonies to the development of the industry.

THE DYE FAMINE IN AMERICA AND THE PROPOSED REMEDY.

RECENT issues of the *Scientific American* (November 6 and 13) contain articles by Prof. T. H. Norton, of the Bureau of Foreign and Domestic Commerce, Washington, dealing with the prevailing shortage of dyes in the United States. For some months after the outbreak of the European war, American importers were able to secure an almost normal supply of synthetic dyes, but during the last seven months, owing to the embargo on the shipment of German dyes to neutral countries, only 50 tons of such colouring matters have reached America, together with small amounts of dyes of Swiss origin.

Before the war, American dye factories employed not more than 400 workmen and produced annually 3000 tons of dyes, these colours being prepared chiefly from intermediate coal-tar products made in Germany.

After a systematic examination of the dye problem by the Department of Commerce, the Secretary of Commerce, on September 30, outlined the policy of the present administration in regard to the protection to be afforded to American chemical enterprise against unfair attacks by foreign rivals. In the meantime, prompt and resolute decisions had been made by the industrialists, and considerable investments were made in new plant, two new companies having an authorised capital of 400,000*l.* and 3,000,000*l.* respectively. The output of American coal-tar colours has been doubled and will soon be trebled, while the production of benzene and toluene has increased fivefold. Owing to the extensive manufacture of explosives, it is difficult at present to secure large quantities of these hydrocarbons for colour production. But twelve firms have nevertheless embarked on the manufacture of aniline, the Edison Company now turn-

ing out three tons of this intermediate product daily. A remarkable and novel development has arisen in this branch of the colour industry. The firms engaged in dyeing aniline black are setting up small aniline plants costing 300*l.* to 400*l.* each, capable, under the supervision of one operative, of producing daily 100 lb. of aniline from benzene.

At present the seven companies engaged on finished coal-tar dyes are restricting drastically the number of colours produced, and are concentrating on increased output. Two works are specialising in an ample supply of chlorodinitrobenzene, from which two other well-equipped factories are manufacturing sulphide black on a huge scale. Synthetic indigo is receiving the attention of four powerful chemical companies.

Although the existing equipment for natural dyes installed in six large American works has proved to be a national asset of great value, yet the total supply of dyes is still far short of customary requirements, and the American public is urged to meet the abnormal situation in a spirit of generous compromise. The existing shortage will soon disappear, inasmuch as the United States possess all the enterprise, inventive talent, and technical ability requisite for the development of an American dye industry. As regards the practical experience of industrial colour syntheses, it is suggested that the services of a corps of expert Swiss colour chemists would be of untold value in accelerating the evolution of the new industry. This scheme has already been adopted successfully in Russia, where a group of dye consumers have formed a company, including as a constituent member a leading Basle firm, which supplies a technical staff to the enterprise.

One reason for the former dominance of German colour chemistry was the unity and solidarity of the various firms engaged in this industry, so that when one was menaced by any foreign competitor they all acted in unison. In America the field has been entered by many separated interests imperfectly acquainted with the complexity of the colour problem. A plea for a higher degree of unity is put forward in order to avoid overlapping and duplication of effort. It has been proposed to establish Government factories for the production of coal-tar intermediates, these factories to be available for manufacturing explosives in case of war. A national bureau of standards for dyestuffs would afford considerable protection to the growing industry, and a similar result would be attained by organising the consumers of dyes.

In view of these developments, it appears certain that in a few years America will be practically self-contained as regards dyes. It is not at all probable that the vast industrial organisations by this time established will content themselves with catering only for the American market, especially as the United States possess sufficient of the needed raw materials to supply the whole world's dye industry. British dye producers must expect to face, not only furtive attempts to recover trade by German competitors, but also a direct frontal attack on their home, colonial, and foreign markets by dye-wares of American origin. The only way of meeting this invasion will be by a combination, first of British manufacturers among themselves, and secondly a co-operative union of the British group with similar groups representing the other nations of the Quadruple Entente. The pooling of our resources for war will need to be followed by a partnership in original ideas, technical organisation, and natural resources in regard to the chemical industries of the allied nations.

G. T. M.

OPTICAL INVESTIGATION OF ETHER-DRIFT.

OF all the attempts made to detect a possible influence of the motion of the medium on optical phenomena, the only one giving a positive result, was the celebrated experiment of Fizeau, in which interference was produced between two beams of light which passed along tubes containing running water, the one beam going with the current and the other beam against it. When the direction of the current was reversed the bands were displaced, and the displacement could be explained on the assumption that the ether in the tubes drifted with the current with a velocity $v(1-1/\mu^2)$, where v is the velocity of the water. Fizeau obtained a 14 per cent. agreement between theory and experiment, which was regarded as satisfactory in view of the difficulty of the subject. The experiment was afterwards repeated by Michelson and Morley with more refined means, and they obtained a difference of less than 1 per cent. with a calculated probable error of about 5 per cent.

In 1895, however, in his "Versuch einer Theorie der electrischen und optischen Erscheinungen in bewegten Körpern," Lorentz gave a new expression for the velocity of the ether drift, namely:—

$$v\left(1-\frac{1}{\mu^2}-\frac{\lambda}{\mu}\frac{d\mu}{d\lambda}\right).$$

This expression is also obtained on the theory of relativity. In the case of water it is quite 3 per cent. larger than Fresnel's value. We have just received two papers reprinted from the Proceedings of the Amsterdam Academy, which describe an elaborate experimental investigation made by Prof. Zeeman at Amsterdam to decide between the two expressions. (Vol. xvii., pp. 445–451, 1914, and vol. xviii., pp. 398–408, 1915.)

The interference fringes were produced by Michelson's method. The length of the tubes was 6 metres and the maximum velocity of the water 5·5 metres per second. As the expression to be tested varies only slightly with the wave-length, the light of an arc lamp could be used as source after it passed through a monochromator. The fringes were recorded photographically; the cross-wires in the focal plane of the telescope came out on the negative, and the displacement of the fringes relative to the cross-wires was

measured. The exposures were from three to five minutes. Photographs are given in the second paper showing the displacement of the fringes for three different points in the spectrum. The results are summarised in the following table:—

Wave-length		Fresnel coefficient		Lorentz coefficient		Experimental value
4500	...	0·443	...	0·464	...	0·465
4580	...	0·442	...	0·463	...	0·463
5461	...	0·439	...	0·454	...	0·451
6870	...	0·435	...	0·447	...	0·445

The calculated probable error of the experimental result is about 1 per cent. of the latter.

The experiment decides conclusively in favour of the Lorentz coefficient. Not only does the absolute value of the result agree better with the latter, but so also does its variation with the wave-length, the figure for the experimental value being 1616 and the figures derived respectively from the Fresnel and Lorentz coefficients being 1572 and 1608. Thus the degree of accuracy has been pushed a stage further in what was regarded as one of our most accurate experiments.

SCIENCE AND WAR.

WE are permitted to publish this week some passages from Sir William Osler's address to the Leeds Medical School on "Science and War" (Oxford: At the Clarendon Press. Price 1s. 6d. net). Sir William writes with authority and with distinction: and all who love good thoughts arrayed in good style ought to buy this address and read it with care. He keeps his head clear, though he has chosen a theme vast beyond imagination. The war transcends our powers of thought; so does science. The war has gone beyond us; so has science. Yet he is able, more than most of us, to measure the working together of the immeasurable forces of science and war: for he has always in his head, and in his heart, the duplicity of science. "I bring to life, I bring to death," says Science. In the war, my Lady Science is busy both ways. She employs artists in death and artists in life; she supplies them—so impartial are abstractions—with asphyxiating gases and with antiseptic dressings; she manufactures with equal mind high explosives and protective vaccines, submarines and motor-ambulances. What a thing it is to be an abstraction, a name for systematised thought; to have no morals, no likes or dislikes; to be nothing but a Latin word for the best way of doing what is to be done.

Sir William Osler, as a true man of science, gives an admirable and well-balanced account of this dual influence of scientific method on the war. He is not only a man of science: he is also a great physician, a notable artist in life. His account of one of the chief base hospitals in France is delightful reading; the speed and precision and modernity of the work achieved are above praise. A strong committee has already taken in hand the compiling of the medical and surgical history of the war. It will be a mighty book. The medical and surgical history of the American Civil War is in five huge volumes; we can scarcely have less than that for the present war.

Toward the end of the address, Sir William says what a good many of our great doctors are saying or thinking. "To one who is by temperament and education a Brunonian and free from the 'common antipathies' and 'national repugnances,' one sad sequel of the war will be, for this generation at least, the death of international science." He thinks that science will suffer grievously by some sort of boycott against Germany; he dreads what he calls "Chauvinism in science." He says that "an impassable intellectual gulf yawns between the Allies and Germany." We think that he makes too much of this fear. The gulf between the Allies and Germany is ethical, not intellectual. There will be friendships broken, and international medical congresses made impossible, and no more honorary degrees from German universities, and no hospitality for hospital workers, and so forth; but these losses will be easily tolerable. Science has her own ways of getting back a bit of her own.

The following extracts from Sir William Osler's address may serve to illustrate its wisdom and style:—

In Time our civilisation is but a thin fringe like the layer of living polyps on the coral reef, capping the dead generations on which it rests. The lust of war is still in the blood: we cannot help it. There was, and there is as yet, no final appeal but to the ordeal of battle. Only let us get the race in its true perspective in which a thousand years are but as yesterday, and in which we are contemporaries of the Babylonians and Egyptians and all together within Plato's year. Let us remember, too, that war is a human development, unknown to other animals. Though nature is ruthless "in tooth and claw," collective war between members of the same species is not one of her weapons; and in this sense Hobbes's dictum that "war was a state of nature" is not true. The dinosaurs and pterodactyls and the mastodons did not perish in a struggle for existence against members of their own species, but were losers in a battle against conditions of nature which others found possible to overcome. In our own day the gradual disappearance of native populations is due as much to whisky and disease as to powder and shot, as witness in illustration of the one the North American Indian and of the other the Tasmanians.

Some of us had indulged the fond hope that in the power man had gained over nature had arisen possibilities for intellectual and social development such as to control collectively his morals and emotions, so that the nations would not learn war any more. We were foolish enough to think that where Christianity had failed science might succeed, forgetting that the hopelessness of the failure of the Gospel lay not in the message, but in its interpretation. The promised peace was for the individual—the world was to have tribulations; and Christ expressly said: "Think not that I am come to send peace on earth; I came not to send peace but a sword." The Abou ben Adhems woke daily from their dreams of peace, and lectured and published pamphlets and held congresses, while Krupp built 17-inch howitzers and the gun range of the super-Dreadnoughts increased to eighteen miles!

And we had become so polite and civil, so cultured in both senses of that horrid word, with an "Is thy

servant a dog?" attitude of mind in which we overlooked the fact that beneath a skin-deep civilisation were the same old elemental passions ready to burst forth.

In spite of unspeakable horrors war has been one of the master forces in the evolution of a race of beings that has taken several millions of years to reach its present position. During a brief fragment of this time—ten thousand or more years—certain communities have become civilised, as we say, without, however, losing the savage instincts ground into the very fibre of their being by long ages of conflict. Suddenly, within a few generations, man finds himself master of the forces of nature. In the fulness of time a new dispensation has come into the world. Let us see in what way it has influenced his oldest and most attractive occupation.

Science is a way of looking at the world taught us by the Greeks—a study of nature with a view of utilising her forces in the service of man. It "arose from the simplest facts of common experience, and grew by the co-operation of the mass of men with human intellect at its highest. And when developed it returns again to strengthen the common intelligence and increase the common good. Above all, more perfectly than any other form of thought, it embodies the union of past and present in a conscious and active force."[1] Man's latest acquisition, it has worked a revolution in every aspect of his life, without so far changing in any way his nature. He is still a bit bewildered, and not quite certain whether or not the invention is a Frankenstein monster. The promise of Eden of full dominion over nature has only been fulfilled in our day. The flower and fruitage has come suddenly within a couple of generations. Even the seed time was but a few years ago, for to the Heidelberg man, looking down the ages from the Glacial period, Aristotle and Darwin are contemporaries, Galen and Lister fellow practitioners. Steam and electricity have upset our weekday relations, and the theory of evolution our Sundays. Like a beggar suddenly enriched man has not yet found himself; and the old ways and old conditions often sort ill with the changing times. New bottles could not always be found for the new wine.

Organised knowledge, science, if living, must infiltrate every activity of human life. There was a difficulty in these islands, which of fruitful ideas, inventions, and discoveries have had the lion's share, but failed to grasp quickly their practical importance. The leaders of intellectual and political thought were not awake when the dawn appeared. The oligarchy who ruled politically were ignorant, the hierarchy who ruled intellectually were hostile. Read of the struggles at Oxford and Cambridge in the "fifties" and "sixties" of the last century to get an idea of the attitude of the intellectual leaders of the country towards "Stinks," the generic term for science. It was not port and prejudice, as in Gibbon's day, but just the hostility of pure medieval ignorance. Those in control of education were more concerned with the issues of Tract 90 and the Colenso case than the conservation of energy and "The Origin of Species." To take but one example. What a change it might have wrought in rural England if, in 1840, when the distinguished Prof. Daubeny was made professor of rural economy, Oxford could have had great State endowment for an Agricultural College. The seed was abundant, and the soil was good, and only needed the cultivation that has been given so freely by members of the past generation, with what results we see to-day at Oxford and Cambridge and in the new universities.

In two ways science is the best friend war has ever had; it has made slaughter possible on a scale never dreamt of before, and it has enormously increased man's capacity to maim and to disable his fellow man. In exploiting the peaceful victories of Minerva, Mars has added new glories to his name. More men are killed, more men are wounded, and consequently more men are needed than ever before in the history of the world's wars. From 1790 to 1913 there were 18,552,200 men engaged in the great wars, of whom 5,498,097 lost their lives (D. E. Smith). In the Balkan wars of 1912–13 there were 1,230,000 men engaged, of whom 350,000 were killed. In the Russo-Japanese War there were 2,500,000 men, of whom 555,900 lost their lives (D. E. Smith). It is estimated that in the present war more than twenty-one millions are engaged! As weapons have improved the losses will be yet greater, and we may expect that at least five or six millions of men in the prime of life will be killed. Within a few years artillery and high explosives, submarines, and aircraft have so revolutionised our methods of warfare that thousands are now destroyed instead of hundreds. The rifle and the bayonet seem antiquated, and one may go from hospital to hospital and not see a wound from the latter, and comparatively few from the former.

In three directions science has scored in a mission of destruction. What a marvellous adaptation of physics, pneumatics, and mechanics is displayed in a submarine, with which the highest standard of wholesale destruction is reached. In a few seconds a vast battleship, itself a product in every part of scientific genius, is blown asunder and a thousand men and boys sent flying into eternity. Or a colossal liner like the *Lusitania*, laden with harmless non-combatants, is torpedoed without warning and above 1200 perish miserably, to the inexpressible delight of a kultured nation, whose school children celebrated the event with a holiday.[2]

On land the field-guns, howitzers, and machine-guns have increased enormously our killing capacity; so much so, indeed, that in self-defence the armies have taken to earth, and from the North Sea to the Alps Europe has become a rabbit warren. High explosives, long-range accuracy, and quickness of fire have made the artillery arm the most effective of the Service. Every device of science has been pressed into use, and the aeroplanes with their observers and cameras have plotted the entrenched lines to checker boards, on to any square of which a rain of shell and shrapnel may be poured. The high-explosive shells, the "Jack Johnsons," and the "Black Marias" have played a great *rôle* in the present war, and not only do they kill and maim, but the shell-shock from commotion puts a large number of men out of action. Against the great Krupp howitzers the forts of Europe have gone down like cardboard houses.

Artillery and quick-firing machine-guns follow hard upon the torpedo as agencies of destruction. Against an oncoming enemy 20 per cent. of men and 60 to 80 per cent. of horses are hit by separate bullets within the "mown area."

Theoretically all is fair in war, but by common consent certain practices regarded as cruel are tabooed, such as the use of explosive bullets. Not so in the present war. Never before has anything been used by man to kill his fellow man equalled in diabolical capacity for cruelty the use by the Germans of irrespirable gas. Had it been a suddenly asphyxiating vapour, such as may have been the breath of the angel of death as he passed over the host of Sennacherib, the action would not perhaps have been thought any more reproachful (in war) than wholesale drowning

[1] Marvin, "The Living Past," second edition, 1915.

[2] Owen Wister, "The Pentecost of Calamity," p. 55.

by the torpedo. But this was a very different matter—agonising suffocation to those who could not escape; many for days gasped out their lives in a slow process of strangulation, others had a lingering illness with urgent dyspnœa, cough, and inflammation of the lungs. The worst types of cases were, I am told, appalling to witness—some who reached England were bad enough.

It is not a little remarkable that the aspect of the war which caught the popular fancy and from which so much was expected has proved comparatively harmless from a killing point of view. "The rain of ghastly dew" of Tennyson's vision, which the Wright brothers and Zeppelin have made possible, is more destructive of property than of life. But the mastery of the air is one of the greatest of the conquests of science. How Leonardo da Vinci would have rejoiced, in this day predicted so confidently by him, to see flocks of wonderful bird-men as much at home in the air as eagles! The development of aircraft and air-guns has added a new arm to the Service, but battles of the airy navies grappling with each other or attacked by shells from land leave few wounded, and the total killed so far is small. An enormous value for observation and the shock of righteous indignation roused all over the world by the Zeppelin murders of women and children have been, so far, the chief assets of the air.

Enough of this. Let us turn to the other side of the picture; let us see what science has done in a mission of salvation amid the horrors of war. Through the bitter experiences of the Napoleonic wars, of the Crimea, of the American Civil War, and more particularly of the recent campaigns, there has been evolved a wonderful machinery, replete with science, for the transport and care of the sick and wounded. There must be suffering—that is war—but let us be thankful for its reduction to a minimum, through the application in every direction of mechanical and other pain-saving devices.

If the foes of our own household, the "anti's," would spend a few days at a hospital for infectious diseases, see the modern methods, and learn a few elementary facts about immunity, they could not but be impressed with the applications of scientific horticulture to disease, and be lost in admiration of a technique of extraordinary simplicity and accuracy.

The second great victory of science in war is the prevention of disease. Apollo, the "far darter," is a greater foe to man than Mars. "War slays its thousands, Peace its ten thousands." In the Punjab alone, in twelve years, plague has killed two and a half millions of our fellow-citizens. This year two preventable diseases will destroy more people in this land than the Germans. The tubercle bacillus alone will kill more in Leeds in 1915 than the city will lose of its men in battle. Pestilence has always dogged the footsteps of war, and the saying is true—"Disease, not battle, digs the soldier's grave." Bacilli and bullets have been as David and Saul, and at the breath of fever whole armies have melted away, even before they have reached the field. The fates of campaigns have been decided by mosquitoes and flies. The death of a soldier from disease merits the reproach of Armstrong:—

> Her bravest sons keen for the fight have dy'd
> The death of cowards and of common men—
> Sunk void of wounds and fall'n without renown.

This reproach science has wiped away. Forty years ago we did not know the cause of any of the great infections. Patient study in many lands has unlocked their secrets. Of all the great camp diseases—plague, cholera, malaria, yellow fever, typhoid fever, typhus, and dysentery—we know the mode of transmission, and of all but yellow fever the germs. Man has now control of the most malign of nature's forces in a way never dreamt of by our fathers. A study of her laws, an observation of her facts—often of very simple facts—has put us in possession of life-saving powers nothing short of miraculous. The old experimental method, combined with the new chemistry applied to disease, has opened a glorious chapter in man's history. Half a century has done more than a hundred centuries to solve the problem of the first importance in his progress.

Lastly, in the treatment of wounds science has made great advances. The recognition by Lister of the relation of germs to suppuration, an outcome of Pasteur's work, has done away with sepsis in civil life. High explosives, shell, and shrapnel make wounds that are at once infected by the clothing and dirt, and are almost impossible to sterilise by any means at our command, but with free drainage, promotion of natural lavage from the tissues by Wright's method, and the use of antiseptics when indicated, even the most formidable injuries do well. The terrible laceration of soft parts and bones adds enormously to the difficulty of treatment. The X-ray has proved a boon for which surgery cannot be too grateful to Röntgen and to the scores of diligent workers who have given us a technique of remarkable accuracy. Other electrical means for detecting foreign bodies have also given good results.

Of the germs blown into wounds from the soil and clothing and skin the pus-formers are the most numerous and most important. Two others have proved serious foes in this war, the germ that causes gas gangrene and the tetanus bacillus. I am told that methods of treatment of wounds infected by the former are giving increasingly good results. The soil upon which the fighting has occurred in France and Flanders is rich in the spores of the tetanus bacillus; the disease caused by it was at first very common and terribly fatal among the wounded. For centuries it has been one of the most dreaded of human maladies, and justly so, as it is second to none in fatality and in the painful severity of the symptoms. No single aspect of preventive medicine has been more gratifying in this war than the practical stamping out of the disease by preventive inoculation. In the first six months of this year only thirty-six of those who were inoculated within twenty-four hours of being wounded suffered from tetanus.

And what shall be our final judgment—for or against science? War is more terrible, more devastating, more brutal in its butchery, and the organisation of the forces of nature has enabled man to wage it on a titanic scale. More men will be engaged and more will be killed and wounded in a couple of years than in the wars of the previous century. To humanity in the gross science seems a monster, but on the other side is a great credit balance—the enormous number spared the misery of sickness, the unspeakable tortures saved by anæsthesia, the more prompt care of the wounded, the better surgical technique, the lessened time in convalescence, the whole organisation of nursing; the wounded soldier would throw his sword into the scale for science—and he is right.

NOTES.

THE Romanes Lecture on "Science and the Great War," delivered by Prof. E. B. Poulton at Oxford on December 7, and published by the Clarendon Press, was a scathing indictment of the ineptitude of the lawyer-politicians who possess a dominating influence on national affairs, and a plea for a fuller use of

scientific knowledge. To the neglect of science, and the excessive predominance in Parliament and in the Government of men with the spirit of the advocate to whom all evidence which will not support their case is unwelcome, Prof. Poulton ascribes the chief mistakes in the conduct of the war. The ignorance displayed in connection with the campaigns to make cotton contraband and to prevent the export of oils and fats, because of the use of these things in the manufacture of gun-cotton and nitro-glycerine, is as appalling as it is deplorable. In all such cases, when vital issues are at stake, our statesmen only make use of scientific evidence when the resources of political rhetoric have failed to justify their inactivity. The pity of it is that so much power should be in the hands of politicians and members of public services unwilling to recognise the important position which science must occupy in a modern State, in times both of war and of peace. Prof. Poulton mentions a number of matters in which scientific advice might have been applied with advantage much earlier in the war, but no appeal was made for such help, and the fate of suggestions was not encouraging. His address should help to enlighten the public as to the prime need of the country for men alert to take the utmost advantage of the power which science can offer.

A NOTE from the Imperial Institute refers to recent statements as to the present scarcity of certain drugs. The shortage and high price of atropine has been particularly commented on and attributed to "the dearth of belladonna, from which [according to this statement] atropine is extracted, and which is obtained from Central Europe." It is most desirable that this common misconception as to the sole source of atropine should be dispelled. Belladonna is one source, but a far more valuable source is (as was proved a few years ago by investigations at the Imperial Institute) the Egyptian hyoscyamus or henbane. This plant grows wild in the Egyptian desert and in the Sudan, and these countries are the sole source of the commercial supply. Before the war Egyptian henbane went to Germany for manufacture, but large quantities of the plant are freely available, and a considerable amount is now in the United Kingdom awaiting manufacture into atropine by drug manufacturers here. Eserine, also used in ophthalmic surgery, the dearth of which is alluded to in the same statement, is a product of the Calabar bean of West Africa, and presumably it is the extreme present pressure on the manufacturing resources of British drug manufacturers, rather than any scarcity of this British raw material, that is hindering the production of the drug.

PROF. E. A. SONNENSCHEIN, in a letter to the *Times* of November 4, described the good results he had obtained in the domestic use of coal through sprinkling a hundredweight of cheap slack with a solution of a tablespoonful of salt in a little less than a pint of water. It is difficult to account for the results achieved through the medium of about one part of a non-combustible and non-supporter of combustion with some two thousand parts of coal, and Prof. Sonnenschein said:—"I would also not exclude the possibility of a psychological process at work." Some explanation of the beneficent effect of this salt treatment has been put forward by Dr. A. Vernon Harcourt, in a letter to the *Times* of December 8. Dr. Harcourt says that the deliquescent property of the salt particles distributed on the slack serves to bind the small particles together, "so that a handful becomes a piece of coke, which burns with a steady glow, like the coke which lumps of coal after giving off their gases leave behind them." The improved combustion which Prof. Sonnenschein claimed may therefore arise from the better access of air in the absence of very small coal and dust, which frequently cause bad smoking in boiler practice from the choking of air passages through the fuel and the grate bars, but the "psychological process" must not be entirely overlooked.

THE Royal Geographical Society has received further news of Sir Aurel Stein's Expedition in a letter dated October 27, from Bokhara. He has done three months' almost continuous travelling down the Altaic region, across the Russian Pamirs, and along the whole length of the Upper Oxus valley. He has made important observations on geography and ethnography in this interesting region. Finally, he reached the railway at Samarkand, and he is now on his way to Meshed for his winter's work about Seistan. The Russian political authorities have been most courteous and helpful towards the expedition. In Wakhan, besides an important old trade route, he has been able to survey a series of ancient ruined strongholds. "Those secluded valleys," he writes, "have preserved a great deal of old-world inheritance in the ethnic types, languages, etc., of their inhabitants, and the materials I could collect are ample."

THE death is announced, in his seventy-first year, of Dr. George A. Heron, well known for his investigations in tuberculosis, and as the author of numerous medical works.

MR. O. A. DERBY, an American geologist who has been chief of the Geological Survey of Brazil since 1907, died on November 27 at Rio de Janeiro, at the age of sixty-four. He was a graduate of Cornell, and had served the Brazilian survey in various capacities since 1875.

THE *Geographical Journal* for December gives some particulars of the career and work of Dr. Richard Kiepert, whose death we announced in August last. Dr. Kiepert was born at Weimar in 1846, and gained his early experience in cartography with his father, Heinrich Kiepert, whose works he revised after his father's death. His contoured wall maps of the countries of Europe are among the best ever published. Among other important work of Kiepert was an atlas of the German possessions, a great part in the preparation of Richthofen's atlas of China, and, above all, a map of Asia Minor, which embodied all available information. For some time Kiepert was scientific director of Reimer's cartographical institute at Berlin, and from 1875 to 1887 he was editor of *Globus*.

MR. THOMAS PARKER, whose death occurred a few days ago, was not only a distinguished engineer, but a man of inventive and gifted mind, who, in addition to his ordinary labours, carried on investigations in realms far outside engineering. He first attracted

attention by his invention of a steam pump, and later came into further prominence through his investigations in electric batteries, the outcome of which was the foundation of a business which ranks to-day among the leading electrical works in England. It was while manager of the Coalbrookdale Company's works that he discovered the great value of concentrated nitric acid in facilitating the formation of the oxide in secondary batteries. R. L. G. Planté, who had been working on the problems of electrolytic polarisation since 1859, made a similar discovery, which resulted in the production of a cell having a high E.M.F., a low resistance, a large capacity, and almost perfect freedom from polarisation. The rival claims were contested in the courts, who divided the patent between Parker and Planté. In 1882 Mr. Parker entered into partnership with Mr. P. B. Elwell, and commenced manufacturing accumulators, and, later on, dynamos. This business was afterwards transferred to the Electric Construction Company of Wolverhampton, of which Mr. Parker became manager and engineer. During the five years which he occupied this position he designed the electrical plant for the Liverpool Overhead Railway. Later he became engineer of the scheme for electrifying the Metropolitan Railway in London. Mr. Parker was foremost in the electro-deposition of copper for subsequent use in the refining of copper, and the extraction of gold and silver. Then the smoke abatement problem occupied his attention, and he invented a slow-combustion grate, and a substance now known as coalite, which, though in appearance like gas coke, was easily ignited and burnt with a bright but smokeless flame. In 1894 he was awarded the Stephenson medal and Telford premium by the Institution of Civil Engineers.

BY the death of Dr. Arthur Vaughan, at the early age of forty-seven, science has again to mourn the loss of a distinguished investigator. Vaughan's early training was in mathematics, which he made his chief subject at Cambridge, where he obtained a first class in both parts of the Mathematical Tripos. After applying his mathematics to an original investigation of certain problems presented by the earth's crust, he devoted himself with great ardour to geology, which had always been his favourite subject, especially on its palæontological side, with its bearings on the great problem of life. Some original work on the Jurassic beds of Somerset, accomplished in conjunction with his friend, Prof. Reynolds, prepared him for an attack on the zonal succession of the Lower Carboniferous rocks, a difficult problem which had resisted all previous attempts at solution. He commenced his investigation in the Avon Gorge, near Bristol, and achieved there a remarkable success. Having firmly established the succession in this section he extended his researches to adjacent regions, and then into provinces more remote, bringing into harmony the order of the Lower Carboniferous rocks and fossils in England, Wales, Ireland, Belgium, and elsewhere. The solution of this problem led to many fresh lines of inquiry, bearing on the laws governing the evolution of animal forms, and on the distribution of the Lower Carboniferous land and sea. While in the final stage of the disease from which he died he left the sanatorium at Buxton to give an account of his latest investigation on this last subject to the British Association at Manchester. In 1910 he accepted an invitation to the newly created post of lecturer in geology in the University of Oxford. Here his brilliant powers as a teacher were at once recognised; he gained the affection of his students and awakened their interest; indeed, it would have been hard to resist the stimulus of his lectures on "Palæontology and Evolution," with their suggestive views on the trend of the great currents of ancient life. He leaves unfinished an important text-book on palæontology, which had occupied many years of his life, and on which he was engaged up to within a few days of his death.

THE reading of Mr. S. H. Haughton's paper on a fossil man from Boskop, Transvaal, before the Royal Society of South Africa on October 20 (reported in NATURE of December 2 (p. 389), was followed by a discussion in which Dr. L. Péringuey expressed the opinion that none of the associated stones were human implements. It was very difficult to correlate the superficial deposits of South Africa with those of Europe, but it was clear that the Boskop man had no connection with the Neanderthal race. Both the Boskop specimens and another less fossilised human jaw which was exhibited must rather be compared with the corresponding bones of existing African types, to which they might be ancestrally related. As to the real importance of these remains there could be no doubt.

THE FitzPatrick lectures recently delivered by Dr. W. H. R. Rivers before the Royal Society of Physicians dealt with the relations between medicine, magic, and religion. Magic he defined to be a group of processes in which man used rites which depended on his own power, or on powers believed to be inherent in, or the attributes of, certain objects and processes which were used in these rites. Religion, on the contrary, dealt with processes dependent on a Higher Power, whose intervention was sought by rites of supplication or propitiation. But the savage mind distinguishes with difficulty between these two groups of ideas. Savage philosophy attributes disease to human agency, to some spiritual being, or to what we ordinarily call natural causes. He dwelt on the important part played by suggestion in the causation of disease among the Papuans and Melanesians, and he remarked that from the physiological point of view the difference between their rude methods and our medicine was not one of kind, but only of degree. The chief lesson to be learnt from the facts described was the rationality of the leechcraft of such peoples. They practised an art of medicine in some respects more rational than our own, for diagnosis and treatment followed more directly their ideas of causation. There were examples of leechcraft, such as the use of bleeding and massage in New Guinea, which did not follow a system so strictly logical and consistent. This led to another set of problems, the transformation of medical beliefs and practices as a result of contact and blending of peoples.

THE *Museums Journal* for December contains a very suggestive article on "Museums and Folk-art," more especially in reference to the folk-arts of the British Isles. Some striking examples of this art are

furnished by carved wooden spoons and stay-busks. These were wrought in the intervals of leisure, not for sale, but as offerings from men to their women-folk. Nor were they meant for use, but as pledges of affection, and hence the symbol of affection, the heart, appears in most of them. Specimens of such carvings, many of real beauty, add much to the value of this most helpful essay, which is unsigned.

The Straits Branch of the Royal Asiatic Society has just published a valuable memoir on the Blattidæ, written by Dr. R. Hanitsch, the director of the Raffles Museum, at Singapore. In the main a compilation, embracing the descriptions of Malayan cockroaches scattered throughout numerous publications, yet much original work is contained in these pages. Dr. Hanitsch, indeed, describes herein nine species new to science. Furthermore, he has made a careful analysis of the geographical distribution of this group. This enables him to show, in the first place, that of 184 known species 131 are peculiar to the Malayan region, and in the second that the geographical distribution of the Blattidæ discounts the view that the Philippines should be included in the Indo-Malayan sub-region. Seven coloured plates add materially to the value of this most useful contribution.

Miss Maud D. Haviland, in the December number of *British Birds,* records her notes made on the grey plover, at Golchika, on the Yenisei, during 1914. These notes chiefly concern the breeding habits of this bird, and form a valuable contribution towards our knowledge of this phase in its life-history. But she also makes some pertinent remarks on the spring migration of this species which are worthy of careful attention. In the same number Mr. H. F. Witherby continues his notes on the moults of the British passeres and the sequences of their plumages. In this he deals with the finches, which have but one annual moult, in the autumn. The snow-finch, however, he remarks, in the spring moults the throat feathers, while some of the nearly allied buntings, at this season, moult parts of the head, throat, and breast feathers. The "juveniles" among the finches in their first autumn usually moult only the body plumage and some of the wing coverts and inner secondaries. But the house-sparrow, tree-sparrow, and the snow-finch, the corn-bunting, and the East Siberian meadow-bunting have a complete moult in the autumn.

We have received another useful pamphlet (No. 79) issued by the Imperial Department of Agriculture for the West Indies, dealing with "Diseases of Lime Trees in Forest Districts," by Mr. Nowell, mycologist to the department. The black-root disease, which may be caused either by *Rosellinia pepo* or *R. bunodes,* is somewhat common in Dominica, and is fully described in the paper. As it appears hopeless to try to cure infected trees, special attention is directed to methods of prevention of attack. Two other imperfectly known diseases, known as "red-root disease" and "pink disease," are also described; the former is known only from Dominica.

The annual report of the Agricultural Department, Dominica, for the year 1914–15, is an interesting record of steady and well-marked progress. The budding of limes on hardy stocks receives attention in connection with the prevalence of root disease in certain districts. It is of interest to notice that though the yield of limes in the year under review was rather smaller than in 1913, the value of the crop was 44,369*l.* more. The high price is due to abnormal conditions, and it is stated that owing to Army and Navy requirements the output of raw lime juice was relatively large. The shipment of coconuts showed an increase, and the progress of the coconut industry is very satisfactory.

The half-yearly meetings of the Agricultural Education Association were held in London during Smithfield week, under the chairmanship of Prof. Somerville. A paper by Dr. T. Milburn, of Lancashire, upon the subject of "Food Production During the Present Emergency," with special reference to war agricultural committees, was discussed, and some valuable suggestions were made in connection with the question of increasing home-grown produce. At the Agriculture Committee meeting, a discussion on the "Training of Women for Farm Work" was opened by Mr. P. Hedworth Foulkes, Harper-Adams Agricultural College, Newport, Salop, who pointed out the lack of facilities for training women in practical agriculture at the present time, and advocated that a minimum course of one month should be provided in such subjects as milking, general dairy work, poultry-keeping, care of stock, feeding and management, and field work of the lighter type. In the chemistry section Prof. Crowther, Leeds University, introduced the subject of the work of the agricultural chemist in relation to the war, and gave a summary of experimental work with palm nut cake, dried yeast, fish meal, etc., as regards their general suitability and value as feeding stuffs. Mr. Gimingham, of the Research Institute, Bristol, indicated the work that had been done with regard to the feeding value of pressed apple pomace and the possibility of the better utilisation of this waste product.

One effect of the present shortage of agricultural labour has been to stimulate interest in all kinds of labour-saving machinery designed for use on the farm. In the current number of the Journal of the Board of Agriculture there is an interesting account of the demonstrations of motor ploughs and tractors recently carried out by some of the county councils and agricultural associations. The machines tested ranged from 8 to 40 h.p., and from 158*l.* to 600*l.* in price. Petrol is the fuel used by the majority of the motors, but one or two run on paraffin, while the large steam tractors are fired with coal or coke. Both the light motor ploughs, combining both plough and motor, and the heavier tractors, hauling a detachable multi-furrow plough, will do good work under favourable soil conditions, but the former are more suitable when ploughing can be spread over several months, while the tractors are favoured where large areas have to be ploughed quickly, and where much haulage and threshing have to be done. These machines have hitherto only been manufactured in small quantities in this country, and their price is much higher than

it need be if the output were on a large scale. One of the well-known Detroit firms is said to have a 20-h.p. tractor, built on the usual lines of the cheap American car, which can be delivered in this country for 70*l*. In the reorganisation of agriculture which Lord Selborne has recently declared to be necessary after the war, it is certain that such labour-saving devices will play a leading part, and it will be a pity if this market cannot be held for our own manufacturers. It seems probable that in the future the demand for pleasure cars will not suffice to keep the existing motor works fully employed, and here is a field in which the manufacturer who has the necessary courage and foresight will reap a rich harvest.

IN a paper on storm frequency changes in the United States (*Monthly Weather Review*, August, 1915, xliii.) M. Henryk Arctowski touches on the problems of the relations of sun-spot activity to the terrestrial atmosphere. His discussion is based on the number and course of the low-pressure areas which crossed the meridian of 100° W. in the United States from 1883 to 1913. There were six storms fewer per year during the years of sun-spot minima than during the years of sun-spot maxima. This agrees with Kullmer's conclusion that years of sun-spot frequency are stormier than those of sun-spot minima, but in this case the increase was only 6·1 per cent. The difference in distribution throughout the year was much greater. Years of sun-spot minima were characterised by a more uniform latitude distribution throughout the year. During years of sun-spot maxima, on the contrary, the latitude distribution is more unequal, being to the north in February, September, October, and particularly November, and to the south from February to May. The action of the increase of sun-spots upon storms seems to be primarily one of co-ordination, and the conclusion is that the annual variation in the geographical distribution of atmospheric pressure must be essentially different in the years of sun-spot maxima from that during years of sun-spot minima.

MODERN mathematics has reached such a high degree of complexity and specialisation that only the shortest and simplest papers appeal to an extended class of readers. The Edinburgh Mathematical Society, in addition to its Proceedings, is now periodically publishing "Mathematical Notes," edited by Dr. G. D. C. Stokes, and printed by Lindsay and Co., Edinburgh. The contents consist mainly of alternative proofs of formulæ in elementary textbooks, much on the lines of similar work in the *Mathematical Gazette*; and on p. 193 we regret to note the presence of a divisor "sin 90°" in a problem on the solution of a right-angled triangle, an element the introduction of which should necessitate a deduction of marks by any examiner if he is really competent. Again, symbols and triangles figure to an extent suggestive of the predominance of similarly named instruments in the concert given in 1908 to the Mathematical Congress at Rome. We have mentioned the *Mathematical Gazette*, and it now remains to direct attention to a fly-sheet issued in the recent copy of that journal (October, 1915) headed "Books, etc., Received," containing a long list, not only of books, but also of periodicals, with lists of titles of contents. This list, while occupying little more than three pages of small print, meets a distinct want. Similar lists have previously been published in the Bulletin of the Calcutta Mathematical Society, and their utility has been fully recognised in these columns, but unfortunately these lists have usually been several years in arrears. At the same time, the fact that this list (if we have not made some oversight) does not contain a single paper on the mathematics of the aeroplane must be regarded, not only as an anomaly, but as a serious indictment against mathematicians.

THE December number of *Scientia*, although less bulky than in pre-war times, falls in no degree behind its predecessors in point of interest. In an article on the constitution of the luminous atom, Prof. Fabry, of the University of Marseilles, shows how, in seeking a suitable model which would have the radiating powers of the atom, it has been necessary to leave the classical dynamics, and that two paths have been opened up. In the first, due to Ritz, the active element of an atom is taken to be a small magnet about which an electron moves in a closed orbit. In the second, due to Bohr, the Rutherford atom—a central concentrated positive nucleus about which a number of electrons move as in a planetary system—is taken, and the difficulty that such a system would radiate its energy too rapidly, avoided by assuming that the energy is sent out only in bundles or quanta. By this means the spectra of hydrogen, helium, and other less simple substances have been reproduced with startling accuracy. In another article Prof. Bragg shows how X-ray spectroscopy sheds light on the constitution of crystals, and in a different field Prof. Ramsay Muir's article on the problems of the future peace, and Prof. Fedozzi's on the lessons the war has taught with regard to the treatment of foreigners domiciled in a country, will be read with interest.

A PAPER on the harbour and coast defence works at Alexandria, Egypt, was read at the Institution of Civil Engineers on November 30 by Mr. D. E. Lloyd-Davies. The city possesses two harbours, the western being under the jurisdiction of the Egyptian Government, and the eastern is being developed by the municipality. The first improvement of the access to the port was undertaken in 1889; the Gabbary dry dock was built in 1900, and important extensions were completed in 1911 at a cost of 282,770*l*., about 50,000*l*. less than the value of the lands reclaimed. The western port now ranks third, after Marseilles and Genoa, among the Mediterranean ports; it has 1850 acres of sheltered area capable of accommodating 250 large vessels 100 yards apart. The value of import and export trade rose from 18,856,000*l*. in 1880 to 52,075,000*l*. in 1908, and the revenue in 1911 reached 325,000*l*. Since 1906, when the author was appointed city engineer of Alexandria, the construction of breakwaters at the mouth of the bay has been proceeded with. These provide a fine pleasure harbour of 600 acres, an additional refuge for light commercial craft, and serve the purpose of protecting the sea-wall.

In the *Atti dei Lincei*, vol. xxiv., No. 2, Prof. P. Pizzotti studies the relative central orbit of a pair of bodies attracting, according to the Newtonian law, but of variable mass. The investigation appears to be based on the assumption that the impressed force is equal to the product of the mass and acceleration, and not to the rate of change of momentum, the effect of variable mass thus being equivalent to a variation in the gravitational constant. The method would thus appear to be strictly applicable to the motion of two electrified bodies with variable charges, or attracting bodies parting with their substance by evaporation, but not to cases of bodies accumulating matter from without.

A recent number of *Scientia* contains an interesting article by Signor Aldo Mieli on Greek science and the characteristics of its development. He directs attention to the fact that while mathematicians hold in high esteem the achievements of Euclid and the investigations of Archimedes, and while the physician finds much to admire in the works attributed to Hippocrates, the chemist and the biologist are disposed to regard Greek speculation on their respective subjects as fruitless. These diverse judgments are due, he thinks, not to any different attitude of the Greek intellect towards one subject as compared with another, but rather to the special characters of the subjects themselves. The aim of Greek thought was the unification of disconnected knowledge. This laid the foundation of true science, but carried with it the tendency to reduce natural phenomena to a rigid geometrical or logical system. The culmination of Greek science was reached by Hippocrates, Aristotle, and Euclid. Hippocrates brought his generalisations to the test of observation; Aristotle in great measure did the same, the value of his results depending largely on the opportunities he possessed for checking them by observation and experiment. Euclid laid a solid foundation in the region of pure mathematics. The successors of the two former long delayed the progress of knowledge by an undue reliance on the dicta of their masters, but the "granitic" fabric of Euclid made possible the work of Apollonius on conic sections, and even the conception of the infinitesimal calculus reached by Archimedes.

Mr. J. H. Gardner, writing with reference to the note in Nature of December 9 (p. 407) relating to the *Archives of Radiology and Electro-therapy*, in which the statement was made that "it is the only English periodical dealing with the subject of X-rays in all its bearings," reminds us that the Journal of the Röntgen Society, of which he is the editor, has for a much longer period dealt fully with this subject. The latter important and excellent journal, to which reference has frequently been made in Nature, is, however, almost exclusively devoted to printing the Proceedings of the Röntgen Society, and therefore does not come within the same category as one dependent for its existence upon the conditions that apply to any other public periodical. For the same reason, we should not confuse the *Electrician*, or a new periodical on electrical engineering, with the Journal of the Institution of Electrical Engineers. This was the distinction we had in mind when referring to the new publication on radiology in all its branches.

Under the title *Archives Russes d'Anatomie, d'Histologie et d'Embryologie*, Prof. A. Dogiel, professor of anatomy and physiology in the University of Petrograd, has commenced the issue of a new periodical intended to make Russian workers in the three branches of biology embraced by it independent of German mediums of publication. All articles will be published in the Russian language, but they will be accompanied by translations into French or English, or summaries, which in no case will be less than three parts the length of the original paper. Three fascicules are to form a volume of about forty-five sheets of Russian text, illustrated by plates produced by the best engravers in Petrograd. The annual subscription will vary according to the number and nature of the plates, but will not exceed 12 roubles (25*s*.) for each fascicule. Subscriptions should be addressed to Prof. A. Dogiel, Pétrograde, Vasili Ostrov, 3e Ligne, Maison 4, logement 16, or to the publisher, K. Ricker, Pétrograde, Rue Morskaïa, 17.

OUR ASTRONOMICAL COLUMN.

Comet 1915*e* (Taylor).—This comet has been observed at the Naval Observatory, Washington, by Mr. H. E. Burton. On December 6, 11h. 33·5m., its position was R.A. 5h. 22m. 42·9s., declination 0° 1′ 36″, quite close to δ Orionis. Its magnitude is not stated.

Spectroscopic Orbit of 12 Lacertæ.—Orbital elements have been obtained for this binary system by Mr. R. K. Young from a series of spectrograms secured at Ottawa. It presents technical difficulties owing to its extremely short period and faint magnitude. Its period remained in doubt until quite recently, and proved to be only 4h. 38m. 3s. The range of velocity is 35 km., the velocity of the system −14·23 km., the projected semi-major axis has the very small value =46600 km., and the mass function=0·0001. The spectrum is of type B2 (Crucian level). The system bears close resemblance to that of β Cephei.

The Use of the Blink-Microscope.—Further series of stellar proper motions found and measured by means of the blink-microscope are given in Circular No. 28 of the Union Observatory, South Africa. On twelve pairs of catalogue plates thirty-five stars with annual proper motions exceeding 0·1″ have been found. Of these seventeen were brighter than the 10th magnitude. Mr. Innes points out that observations of wide double stars justify the assumption that the vast majority of the stars on the plates is relatively "fixed" (*i.e.* moving as a group). Thus after picking out the proper-motion stars it would suffice for astrographic chart purposes to measure a mere dozen or so stars per plate, a proceeding which would cut down the vast programme of the Carte du Ciel Comité to 100,000 stars.

The Structure of the Spectrum of the Solar Corona.—The recent brilliant application of Planck's quantum theory to the explanation of some celestial spectra by Prof. J. W. Nicholson demonstrated that vibrations of a hypothetical dynamical system—the so-called protofluorine atom—should be capable of giving rise to the majority, but not all, of the then known lines in the spectrum of the solar corona. Among those not so picked up were three prominent lines, one of these being the well-known λ 5303, the others having wave-lengths 4359 and 3534 Å. Prof. Nicholson stated that the cube-roots of the wave-lengths of these lines differed by a constant quantity,

a community of origin being thereby probably indicated. M. P. Carrasco now points out (*Comptes rendus*, vol. clxi., p. 631) that there is an additional member of this series, the next earlier term being the red line at λ 6374·2. This line, unknown when Prof. Nicholson was pursuing his investigations, was the most important feature of the coronal spectrum as photographed at the late eclipse (August 21, 1914), and M. Carrasco was one of the fortunate observers who obtained a record of the line.

AREAS OF ABSORPTION MARKINGS ON SECTROHELIOGRAMS.—The results of the limb prominence observations made at Kodaikanal Observatory during the first half of the current year are given in Bulletin No. 47. The mean daily area is the largest since 1908, and shows an increase of 59 per cent. over that for the preceding six months. Prominences seen projected on the disc as absorption markings on spectroheliograms taken in the light of the Hα reversal are being specially recorded with the grating spectroheliograph for measurement. Mean daily areas in millionths of the sun's visible hemisphere and mean daily numbers for the five half-years 1912–13, and January–June, 1915, are published in the above bulletin. For the second half of 1913 the areas were sixty, whilst for the first half of the present year they were 1375·6. The distribution in latitude of these markings shows the prominence maximum between 50° and 60°, together with a pronounced maximum about 30°, due to prominence in spot latitudes, the equator being avoided, as in the case of sun-spots.

THE CORROSION OF METALS.

ON December 8, under the presidency of Sir Robert Hadfield, the Faraday Society held a discussion on the corrosion of metals. Of the seven papers contributed, only two dealt with the more general aspects of this very important question. Three were concerned with the corrosion of iron, and some of the numerous steels which find application in modern industrial life; the remaining two had reference principally to marine condenser tube alloy, 70 : 30 brass. As it turned out, there was almost no discussion on the fundamental characteristics of corrosion phenomena. During the first hour instances of corrosion among iron alloys came under review, the remainder of the evening being devoted to a consideration of the corrosion of copper-zinc alloys.

As Dr. Rideal pointed out in his printed contribution to the more fundamental aspects of the question, "the phenomena observed in the corrosion of metals are to be found scattered among the earliest records of mankind, and in consequence of the universality of the subject we have received a heritage consisting of a jumble of facts and theories." The first report by Dr. Bengough to the Corrosion Committee of the Institute of Metals consists mainly of a critical examination of the views held with regard to the cause, or causes, of the corrosion of marine condenser tube alloy, the general conclusion being that the evidence is so conflicting that no particular view can be regarded as at all firmly established. The committee, therefore, in planning the experimental investigation decided that there was nothing for it but to begin at the very beginning and take nothing for granted.

Dr. Rideal's definition of corrosion is as follows:—"Corrosion may be said to result from an irreversible chemical change proceeding with a small velocity and taking place on the common surfaces between two or more phases, the products of which change are continually removed from the sphere of action." Moreover, it takes place generally on the surfaces of phases which are electrically conducting, a fact which lies at the base of the now generally accepted electrolytic theory of corrosion. This theory requires the presence of minute cells operating on the surface of the corroded metal or alloy. As yet, however, there is no information as to the number of such cells or the rate at which they work.

Dr. Desch's contribution dealt with the influence of physical and mechanical factors in corrosion, an aspect of the subject the importance of which is by no means always adequately realised. Although the process of corrosion is probably in all cases initially one of chemical solution, the physical heterogeneity of the metal or alloy has a considerable influence on its nature and velocity. More especially has this to be considered when it is remembered that many of the commonly used industrial alloys are in a "strained" condition, and contain, as Dr. Beilby has shown, films of amorphous material on the surfaces of slip of the crystals. Such films have been demonstrated to be more electropositive than the crystalline material, a fact which determines the course of corrosion of cold-worked metals in particular. The increased corrodibility of such alloys is no doubt also partly to be ascribed to the energy produced by work being stored up in these films.

The Cumberland process for preventing the corrosion of metals immersed in liquids, of which a demonstration was given at the close of the discussion, is based upon a recognition of the galvanic nature of this phenomenon. It consists in introducing a higher counter-electromotive force to that causing the corrosive action. A continuous current working at 10 volts is supplied to the anode, consisting of pieces of iron suspended in the liquid and insulated from the vessel being protected. It is claimed that this system has been in use in all types of steamships and in many large power plants, and that it is applicable to any metal in contact with water or any other corrosive liquid.

H. C. H. CARPENTER.

VISCOSITY OF OILS.

THE Institution of Petroleum Technologists is one of the most recent of our technological associations. Founded in 1913, to advance the study of mineral oils from the various points of view of the chemist, the geologist, the engineer, the prospector, and the financier, it has shown from the first a healthy vitality and the promise of a vigorous future. At a general meeting held on November 16, at the Royal Society of Arts, the institution had the pleasure of listening to an illuminating address by Dr. Glazebrook on the viscosity of oils in relation to the rate of flow through pipes. The tests described had been undertaken at the request of the Admiralty, and permission had been given for their publication. The results of the investigation showed that the ordinary law of viscous flow, $P/V=2\eta/9gd^2$, holds good in the particular case postulated so long as the critical velocity which is given in the expression $\rho Vd/\eta=2500$ is not exceeded.

Many experimental difficulties were met with in the actual measurements, which were carried out in the engineering department of the National Physical Laboratory by Mr. Pannell. The small variations in pressure were measured by means of a sensitive mercury tilting gauge, and the quantity of oil passed per minute through the pipes was measured on an Avery weighing machine. Thermal changes were eliminated by jacketing and careful electrical heating.

In general excellent agreement was found between the calculated and observed values of P/V through a wide temperature range.

Part ii. of the research was occupied with the determination of the physical contents of the various oils which were used. The densities call for little com-

ment, the change in density being proportional to the change in temperature. The viscosities were determined in the Redwood I. and II. instruments, from which absolute values can be obtained by means of the relationship $\eta/\rho = AT - B/T$, where A and B are calibration constants of the viscometer. The most marked observation in the viscosity results was the relatively enormous temperature coefficient exhibited by the Mexican fuel oils. Further, the results were shown to be dependent on the previous history of the oil. For example, an oil kept at 32° F. for six days showed an increase in viscosity at 60° F. amounting to 20 per cent., while a similar specimen, heated to 93° F. for the same period, exhibited a decrease of 11 per cent. This hysteresis effect was shown to have considerable practical importance in the handling and utilisation of such oils. The viscosity of mixtures of Mexican and shale oils was described; the viscosity-concentration curves are not linear, but are sagged, and thus it happens that a relatively small addition of shale oil to Mexican oil causes a considerable decrease in the viscosity. Careful tests were also made respecting the flash points of the oils, and their mixtures. The observation was made that a bulk sample of oil flashed somewhat lower than the small amount used in the Gray instrument. These experiments were carried out by Mr. W. F. Higgins.

Dr. Glazebrook concluded by pointing out that much work remained to be done in connection with the physics and chemistry of the mixtures of complex bodies which constitute fuel oils.

QUEENSLAND RAINFALL.[1]

MR. H. A. HUNT, the Commonwealth Meteorologist, has in previous reports given concise histories of the rainfall for New South Wales and Victoria, the volume under notice being thus the third of the series to be published. This report contains all the available annual totals and number of days with rainfall recorded to the end of the year 1913 for 1040 stations in Queensland, and in addition monthly values up to the end of 1912 are given for 137 stations, so distributed as to afford a good representation over the area under consideration. Many of the records go back to 1880, and even earlier, so that a good working basis is provided for investigators who require information in regard to local seasonal rainfall, or who may wish to compare the annual variations of rainfall in this part of Australia with those of the other States of the Commonwealth. Every effort was made to obtain trustworthy data, and in addition to the official records, all possible sources of information, such as histories of Queensland and old newspaper files, were searched. Much labour was involved in the elimination of discrepancies which so often appear when the same record is published in separate reports. A very useful appendix contains tables showing the monthly and yearly values of the meteorological elements (except wind direction and velocity) at Brisbane from 1887 to 1912.

The volume is copiously illustrated by maps and diagrams, among which may be mentioned twenty-seven annual rainfall maps covering the period 1887 to 1913, a map of mean annual rainfall, monthly normal rainfall maps, an *interim* rainfall map for Papua, and a frost map of Australia. Among the diagrams are several showing the height reached by various floods at the stations belonging to the hydrometric branch of the service, and graphs giving the mean annual rainfall of the whole State of Queensland and its sub-divisions. An interesting chronological history of remarkable atmospheric occurrences fills 96 pages of the report, the data being discussed back to the middle of last century. It is worthy of note that only four displays of the Aurora Australis are on record, the cases observed occurring in the years 1869, 1870, 1894, and 1909.

For the twenty-six years, 1888 to 1913, the mean annual rainfall for the whole State is 26·50 in., that of 1894, the wettest year, 40·39 in., and of 1902, the driest year, 12·63 in. The wettest year was thus 52 per cent. above the average, while the driest year showed a defect of the same amount. In the fourteen years, 1892 to 1905, only four exceeded the average, the disastrous effect of this long-continued drought being well shown in Diagram A, giving the total number of live stock, which fell from 27 millions in 1895 to 10 millions in 1902, the decline being checked in 1903 by a rainfall in excess of the normal.

The large average rainfall map which accompanies the report shows that the maximum rainfall, indicated by the isohyet of 160 in., is centred in the vicinity of Harvey Creek (lat. 17° S., long. 146° E.), and that for about 80 miles north and south of this point a rainfall exceeding 70 in. falls on the coast and for some distance inland. An annual rainfall of 70° in. is also found on the coast in four small patches located in latitudes 15° S., 21° S., 27° S., and 28° S. The smallest rainfall under 10 in. occurs in the west and south-west of the State south of 23° S.

It would have materially helped in the elucidation of the problems pertaining to rainfall distribution had the orographical features been indicated on this map. Queensland being in the monsoon region, the heaviest rains occur in summer, while the winter is usually quite dry.

The appearance in recent years of numerous memoirs dealing with Australian climatology is a marked tribute to the rapidly-growing activity and efficiency of the Commonwealth Service, the example of which in this respect will, we hope, be followed by other weather bureaux in the southern hemisphere.

R. C. M.

[1] Meteorology of Australia. Commonwealth Bureau of Meteorology. Results of Rainfall Observations made in Queensland, including all available Annual Rainfall Totals from 1040 Stations for all Years of Record up to 1913, together with Maps and Diagrams. Pp. 285. (Melbourne, 1914.) Price 10s. 6d.

CHEMISTRY OF FIRE AND EXPLOSIVES.

IN a recent issue of the *Revue Scientifique* (September 25–October 9) Prof. A. Job has an interesting article upon the chemistry of fire and explosives. After considering the conditions for, and reactions during, ordinary combustion, the connection of explosion with combustion is described. It is pointed out that, in addition to the volume of gas evolved, heat developed, temperature attained, and pressure, another important factor remains, the rapidity of explosion. This leads to a distinction being drawn between explosives suitable for use as propellents, by reason of their progressive combustion, and what are termed in this country "high explosives," where the decomposition is initiated and propagated by shock (detonation). Mercury fulminate, nitrogen iodide, and lead azide are discussed as types of these sensitive detonating explosives. Fulminate is employed in detonators in France, lead azide being preferred in Germany, it being less sensitive to the decomposing action of moist heat.

As bursting charges for shells picric acid and trinitrotoluene are discussed, it being pointed out that whilst the former combines with metallic oxides, such as those of iron and lead, giving very sensitive compounds, and hence dangerous, the trinitrotoluene is free from this disadvantage. The higher melting

point of picric acid (122°) than that of trinitrotoluene (82°) is another disadvantage, but this may be overcome by the use of certain eutectic mixtures. One such contains forty parts of picric acid with sixty parts of trinitrometacresol (*cresylite*). The mixture melts at 85°, and, after solidification, on reheating becomes plastic at 70°, which permits of compression to high density in the shell.

The various smokeless powders are dealt with, Vieille's work in the development of pure nitrocellulose powders receiving special mention. It is pointed out that, in addition to control of the rate of burning by variation in the form and size of the pieces, a greater proportion of the more slowly burning "soluble" nitrocellulose affords a means of control; thus for small arms the "soluble" may be 25 per cent., for large marine guns 50 per cent., the remainder being "insoluble" nitrocellulose.

Nobel's invention of the use of nitroglycerine as a non-volatile solvent is referred to as a great improvement, there being many disadvantages in the use of volatile solvents. A more recent non-volatile gelatiniser is dinitrotoluol, the Italian Avigliani powder being composed of "soluble" nitrocellulose fifty parts, "insoluble" N.C. twenty-five parts, dinitrotoluene twenty-five parts.

The use of stabilisers is next considered. It is shown that nitrocelluloses, like other nitric ethers, are liable to slow hydrolysis, with the formation of oxides and acids of nitrogen, these actions being promoted by moisture and rise of temperature, the rate being greatly increased by the catalytic action of the products. These actions lead to irregular ballistics, and even to spontaneous ignition. Stabilisers, of which diphenylamine is the most generally used (in ballistite, BN powder, etc.), absorb the liberated nitrogen compounds and prevent, or at least greatly retard, the decomposition.

In conclusion, particulars are given of the celebrated 75 mm. French gun. The projectile weighs 7·2 kilos., and has a muzzle velocity of 529 metres per second. The charge of powder B, in flake form, is 720 grams. It is shown that the gun, as a heat engine, gives an efficiency of 35·1 per cent. To an increase in this efficiency the author looks for further progress in the future.

THE MINUTE LIFE OF THE SEA.[1]

THE quantitative examination of the microplankton of the North European waters is the subject of the present important memoir, which is the outcome of a resolution of the International Council to take advantage of cruises in Denmark, England, Holland, Norway, and Sweden in the spring of 1912 for the collection of plankton samples taken by means of the water-bottle at depths ranging from 0 to 100 metres and more. In this way a series of accurately determined species is followed from sample to sample, and the distribution of these species is used to illustrate the laws of production and destruction of organic substance in the ocean. Prof. Gran has exhaustively examined the whole of the material collected with the exception of the greater part of the Scottish collections, for which Miss Ogilvie is responsible; a special chapter being devoted to this portion of the work. The samples were all preserved by adding Flemming's solution to the water directly it was collected. This method, although admittedly restricted, answers well for the preservation of all important Plankton species, as is shown by the fact that, when comparing the living material from Flødeveigen, Skager Rak, with the preserved, no species were found which were not present in the preserved material. For examination, Lohmann's centrifugal method is used, and the number of organisms (cells) per litre given in a series of tables with hydrographical data. Even delicate Peridiniales such as Gymnodinium, and Infusoria, especially Labœa, are well preserved, and are shown to form an important part in the economy of the sea.

Part i. gives a descriptive account of the plankton from each area taken separately. Of these the Danish results from the Skager Rak, taken both in February and in June, are of special interest. The colder surface water of the Skager Rak in February is found to contain an exceedingly rich Diatom plankton, which the author attributes not to the low temperature, but probably to the fact that the surface water is specially rich in some nutritive substance necessary to the development of the Diatoms. In June, this rich surface Diatom plankton has almost entirely disappeared, different species of Ceratium taking their place. The Danish water investigations also bring out striking results with regard to the relations existing between the assimilating algæ and oxygen tension in the different layers.

In Part ii. new light is thrown upon the distribution and biology of the separate species. *Nitzschia delicatissima*, Cleve, is found to be the commonest of all species in the plankton from the ocean round the Shetlands and the Faroes, having in places the large density of more than a million cells per litre. With regard especially to the Ceratium species, it is shown that passive sinking of the cells plays an important part in their vertical distribution, and this statement applies also to many of the other genera. The species of Labœa are true surface forms and are very abundant: "The whole of the ocean round Scotland and the Faroes contains, at the surface, on an average, one for each cubic centimetre of sea-water."

In the extensive discussion on general conditions of life and of plankton production, taking the many factors into account, the conclusion is arrived at that with the assimilating algæ the optimum production is near the surface, although the maximum at certain periods may be at a greater depth. Thus, in the case of the Ceratium species, although in the present investigations the greater number were found to occur at depths between 15–20 metres, it does not follow that this represents the depths of optimum production. In fact, other researches show it to be generally nearer the surface. The author suggests that by far the greater number of the assimilating plankton algæ have their maxima close to the surface, probably not as deep as 10 metres.

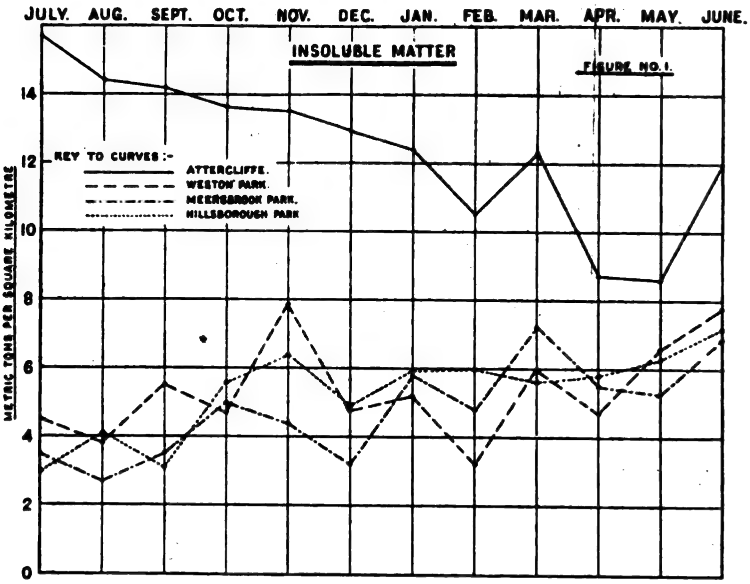
The last portion of the work on the horizontal quantitative variations of the plankton shows the influence of the coastal waters on distribution. The entirely different conditions of the area round Scotland and the Faroes compared with the Skager Rak and the north-eastern corner of the North Sea is thus explained by their supply on the one hand from Scotland and the Faroes, and on the other through the Baltic current from the Scandinavian coastal sea. Throughout the investigation runs the same idea binding the whole together and emphasising the importance of a permanent supply of nutritive substance from land. This nutritive substance taken up by the sea forms the means of subsistence of all plankton organisms which, originating from the coastal waters, spread out from thence into the more distant waters of the ocean.

M. V. L.

[1] H. H. Gran: "The Plankton Production in the North European Water in the Spring of 1912." Conseil Permanent International pour l'explorations de la Mer. *Bulletin Planktonique* pour l'année 1912 (continuation du Bulletin Trimestriel des résultats acquis pendant les croisières périodiques et dans les périodes intermédiaires, Partie D). Publié par le Bureau du Conseil avec l'assistance de C. H. Ostenfeld, chargé du service planktonique.

ATMOSPHERIC POLLUTION.[1]

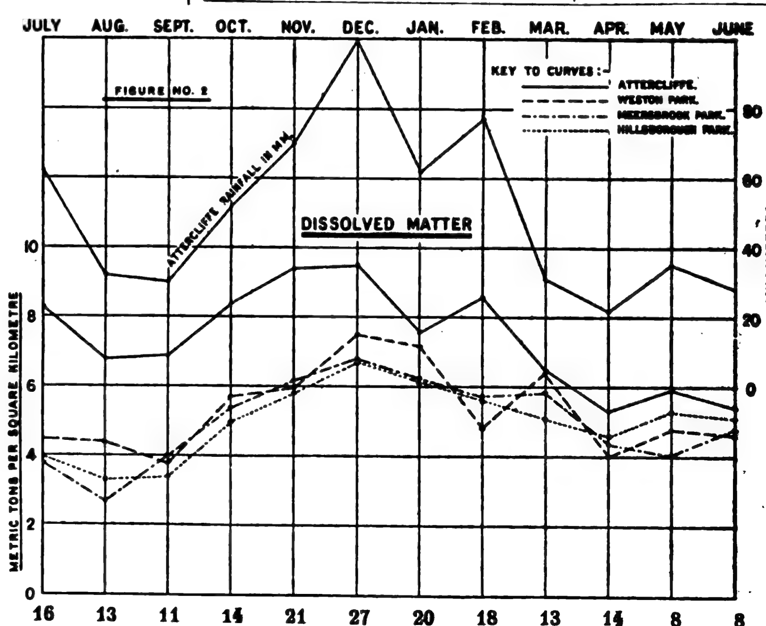
As recorded in NATURE of December 17, 1914 (vol. xciv., p. 433), Sheffield is one of the cities joining in the observations on atmospheric pollution arranged by a committee representative of the Smoke Abatement Societies of the United Kingdom. The monthly results of the chemical examination of rain-water collected at four sites, approximately N., S., E., and W. of the Town Hall,[2] have been published in the *Lancet*, and are being embodied in the annual report of the medical officer of health of the city of Sheffield. The results do not accord with expectation, and certain conclusions have been reached which are perhaps of more than local interest, as they throw doubt on the value of chemical analyses of rain-water, either in the investigation of atmospheric pollution or in a comparison of the extent of pollution in different localities. It should be borne in mind that in Sheffield the distinction between factory and domestic smoke, which is based on the relative amounts of tarry matter and ammonia in the atmosphere (this journal, *loc. cit.*), cannot be drawn owing to the large number of reheating and annealing furnaces in operation in the east end (where the large steel works are situated), for which coal is burned so as to produce the smoke necessary for the metallurgical processes involved.



The curves, which show the total amount of insoluble matter (Fig. 1), and the total dissolved matter (Fig. 2) found in the rain-water collected at the end of each month, indicate for the three parks some deterioration of the atmosphere, as might be expected from the abnormal conditions arising out of the war. But the unmistakable evidence of diminishing pollution which the Attercliffe curves suggest, finds no support from what is known about the difficulties encountered in the east end with plant on war material contracts pushed to its utmost capacity, with fuel, and with the shortage of competent firemen, and it is in conflict with the sunshine records for Attercliffe, which show no improvement when compared with the average of the preceding ten years,[3] and with the number of warnings about excessive smoke emission issued by the smoke inspector, which show no decrease when compared with the average of the two preceding years.[4]

The total amount of each constituent determined in the rain-water collected at the four sites during the period July 1, 1914, to June 30, 1915, is set out in metric tons per square kilometre in the table:—

Site	Insoluble			Dissolved		Total solid matter	Sulphate (SO_4)	Chloride (Cl.)	Ammonia
	Tar	Combustible	Ash	Loss on Ignition	Ash				
Attercliffe	2·84	43·20	105·27	22·11	66·70	240·12	30·00	18·29	0·87
Hillsboro'	1·60	14·20	48·00	11·37	49·13	124·30	23·54	9·33	0·53
Meersbrook	1·68	14·78	41·07	12·96	46·83	117·32	24·02	9·36	0·53
Weston Park	2·15	15·40	47·55	17·01	46·92	129·03	25·23	9·14	0·53



No. of days in each month on which rain fell in Sheffield.

[1] Communicated in abstract to Section B (Chemistry) of the British Association, at Manchester, on September 9, 1915, and abridged from a Report made to the Health Committee of the Sheffield City Council in September, 1915, by Prof. W. P. Wynne, F.R.S. The whole of the chemical analyses were made by Mr Percy Haller, who was also responsible for the collection of the rain-water from the gauges.

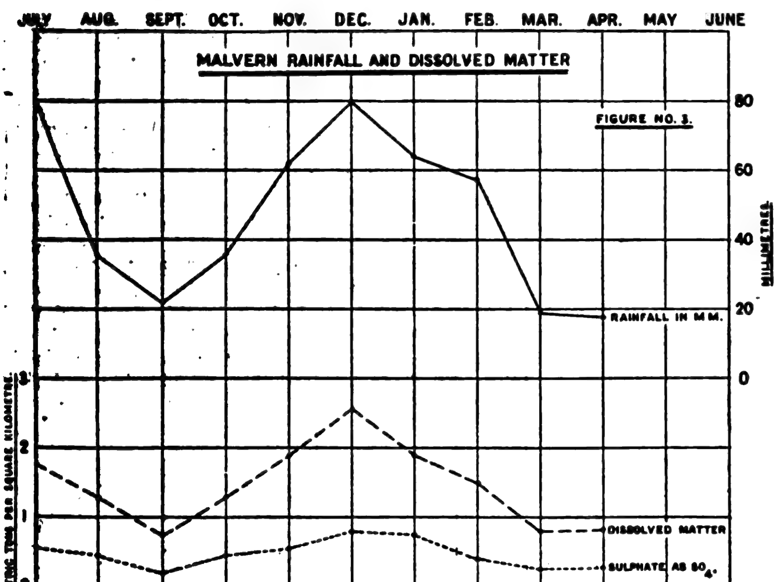
[2] Attercliffe (Don valley), gauge approximately 2 miles E.N.E. of Town Hall and 148 ft. above sea-level; Hillsborough Park (Don valley), gauge approximately 2 miles N.N.W. of Town Hall and 250 ft. above sea-level; Meersbrook Park (Ruskin Museum), gauge approximately 2 miles S. of Town Hall and 362 ft. above sea-level; Weston Park (University), gauge approximately 1 mile W. of Town Hall and 425 ft. above sea-level. Each gauge was placed on the ground-level and at a sufficient distance from buildings to render the results comparative.

[3] Mr. E. Howarth, Curator of Weston Park Museum, has supplied the following information: Bright sunshine registered at Attercliffe during period July 1, 1914, to June 30, 1915, 1029 hours (average 1008 hours); at Weston Park, 1377 hours (average 1322 hours); at Bournemouth, 1791 hours (average 1740 hours).

[4] Warnings in 1912 and 1913 were 261 and 244 respectively, and in the period July 1, 1914, to June 30, 1915, they were 251.

From these figures it will be seen that, while the amount of suspended combustible matter (carbon and tar) and mineral matter in the Attercliffe atmosphere is from 2·5 to 3 times as great as in that of the other districts, that of dissolved matter is not more than 1·5 times as great.

These figures furnish no clue to the amount of impurity in the atmosphere, except when rain is falling; nor is it clear to what extent allowance must be made for the amount of soluble matter dissolved by the same volume of rain when it falls in large drops and rapidly in one district but slowly and in a finely divided state in another. At the best, they represent a minimum value; they take no account of pollution during rainless periods, and to convey an approximate idea of the foulness of town atmospheres each monthly result would need to be multiplied by some factor derived from the proportion of rainless to rainy periods in the month. It is doubtful, therefore, whether a comparison of results obtained at different stations in the same observing area, or from different towns, under the Organising Committee's scheme of rain-water investigation, can have much value until something is known of the extent to which the data are dependent on the duration of the rain per month, or on the number of days on which rain was collected, or on the rate at which the rain came down, or on the direction and velocity of the wind during the dry and wet periods in the month.



Of all these influences which affect any scientific interpretation of the rain-water data, the only one that can be tested is the rainfall per month. To ascertain the influence which monthly variations in the rainfall may exercise on the amount of impurities washed out from the atmosphere by the falling rain, it is desirable to select the case of a town like Malvern, which is practically free from industrial smoke. As the pollution of Malvern's atmosphere may be assigned to one source—household fires—it might be expected to increase with the seasonal fall in temperature: to be greater in the winter than in the summer months. The figures (metric tons per square kilometre) for the period July 1, 1914, to April 30, 1915,[5] as published in the *Lancet* to the end of September, 1915, are given in the following table:—

	July	Aug.	Sept.	Oct.	Nov.	Dec	Jan.	Feb.	Mar.	April
Tar . . .	0·01	0·01	0·01	nil.	0·01	0·01	trace	—	—	0·01
Insoluble matter	0·71	0·71	0·81	0·42	0·46	0·84	0·12	0·25	0·21	0·27
Dissolved . .	1·76	1·30	0·72	1·29	1·92	2·54	1·93	1·47	0·81	0·80
Total solids	2·47	2·01	1·53	1·72	2·38	3·39	2·06	1·72	1·02	1·07
Sulphate (SO_4) .	0·56	0·47	0·18	0·43	0·53	0·79	0·74	0·41	0·28	0·25
Chlorine (Cl) .	0·35	0·13	0·12	0·19	0·36	0·56	0·24	0·41	0·10	0·11
Ammonia . .	0·05	0·03	0·00	0·02	0·0[illegible]	0·02	0·01	0·01	0·01	0·12
Rainfall in mm.	80	36	22	36	61	80	64	57	19	17

While the figures recorded for insoluble matter, including tar, are not easy to interpret, those for dissolved solids and for sulphate seem at first sight to indicate an increase in pollution with the advent of winter. But they bear another complexion when plotted against the measured monthly rainfall, as will be clear from an inspection of diagram No. 3, and the criticism may be ventured that, for a town like Malvern, the Organising Committee's scheme of chemical investigation might serve better as a means of recording variations in rainfall than as a method for determining the extent of variation of atmospheric pollution. Nor is this criticism disarmed in the case of a manufacturing town like Sheffield, in which atmospheric pollution is due partly to industrial smoke—fairly constant in amount all the year round—and to domestic smoke, varying in amount according to the season, for when a comparison is made of the curves for the rainfall and for the dissolved solids and the sulphate, a similar correspondence in shape can be traced. As an illustration, the Attercliffe rainfall curve is shown in Fig. 2 above the curve for dissolved matter for the same district.

It seems probable that the chemical investigation of atmospheric pollution by the rain-water method could give comparative results only if rain fell at a unform rate, and either all day or at the same period of each day, conditions not attainable in nature. Notoriously, Sheffield's atmosphere is at its worst on a calm day; there were many days during last winter when the University building, 250 ft. above the Don valley, was enveloped in a smoke fog, but as no rain fell the pollution of the atmosphere, so evident to the senses, found no record in the chemical analyses of the rain-water collected on other days than these. Better results might be obtained if a feasible method could be devised for drawing air continuously and at a given rate through water, but whether their value, as evidence of atmospheric pollution, would be commensurate with the cost is a question which experiment alone could decide. If the British Association could see its way to appoint a committee to investigate the comparative merits of chemical and physical methods of studying atmospheric pollution,[6] new processes might be devised which would furnish evidence of avoidable pollution (the main object of the inquiry into the smoke nuisance) more readily and at less cost than the chemical analysis of water used to wash impurity out of the air.

[5] The Malvern results for May and June, which have since been published (*Lancet*, October 9, p. 822; November 6, p. 1046), support the conclusions drawn from the earlier data.

[6] Since this paper was read, a committee of the British Association has been appointed to report on "Fuel Economy and Smoke Abatement" (see p. 205.)

Subject to the limitations imposed on any comparative treatment of the results recorded for the towns which have taken part in the inquiry, it may be of interest to point out that, after allowances have been made for differences in rainfall, Sheffield, according to the analytical data published in the *Lancet*, is a less smoky city than Manchester. This conclusion follows from a comparison of the figures for the six stations, N., E., and S., situated within three miles of Manchester Town Hall (Salford, on the west, did not take part in the inquiry), with those for the four stations, roughly, N., E., S., and W., situated within two miles of the Sheffield Town Hall. How far such evidence justifies the conclusion that Manchester chimneys pour into its atmosphere a correspondingly larger amount of impurity is doubtful; the contour of the land as promoting or retarding the dispersal of smoke is one of many factors to be taken into account before a definite opinion should be hazarded, and no two towns could differ more than Manchester and Sheffield in this respect.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

IT is stated in the issue of *Science* for November 26 that approximately 200,000*l*. is to go to Yale University under the will of the late Mr. Justus S. Hotchkiss, of New Haven. The trust fund thus established is to be shared equally among the academic, law, and theological departments.

THE Cambridge University Press has published "The Book of Matriculations and Degrees: a Catalogue of those who have been matriculated or admitted to any Degree in the University of Cambridge from 1901 to 1912." With the present volume the period covered, so far as a record of degrees is concerned, is from 1544 to 1912. Honorary titles of degrees conferred from 1901 to 1912 are included. The catalogue has been prepared for the press by Mr. B. Benham, the assistant registrary, and Mr. C. J. Stonebridge, the registrary's clerk. The price of the volume is 12*s*. 6*d*. net.

DR. JOHN READ, lecturer and demonstrator in chemistry in the University of Cambridge, has been elected to the chair of organic chemistry—pure and applied—in the University of Sydney, in succession to Prof. R. Robinson, lately appointed to the chair of organic chemistry at Liverpool. Dr. Read was educated at Sexey's School, Bruton, Somerset, passed through the Finsbury Technical College, under Prof. R. Meldola, in 1901–1904, was at Zürich with Prof. Alfred Werner, 1905–7, and has since been associated with Prof. W. J. Pope at Manchester and Cambridge, having published in collaboration with him a considerable number of papers of stereochemical interest.

THE sixteenth annual meeting of the Association of Public School Science Masters will be held on January 4 and 5, under the presidency of Sir William Osler, who will open the proceedings with an address entitled "The Fateful Years, 1915–1917," in which he will make a plea for earlier and more intensive work in science subjects so as to save time at the universities. The programme also includes the following papers and subjects for discussion:—"Desirability of Giving a Bias towards Agriculture in the Science Teaching in Schools," C. Turnor; "School Museums," M. D. Hill; "War-Work in Schools," S. J. Hough; "The Extent to which it is Desirable to Modify the Teaching of Science in Schools to Meet the Requirements of War," C. L. Bryant.

DR. E. FOX NICHOLS has resigned the presidency of Dartmouth College, New Hampshire, which he has held since 1909, in order to accept an invitation to a chair of physics at Yale. In his letter to the Dartmouth trustees he explains that the special needs of the college which led him to accept the headship have now been largely met, and that there seems therefore no compelling reason why he should not go back to his earlier work, the duties and recompenses of which are in fuller accord with his individual taste and preference. The incident has aroused a good deal of favourable comment in the American Press, as indicating a break in the general tendency, in American academic circles, to prefer the attractions of an administrative post to the claims of scientific research and teaching.

THE approaching retirement of Dr. William Garnett from the post of educational adviser to the London County Council demands some grateful reference to years of work that have left a permanent mark upon London education. A student of the Royal School of Mines and a Whitworth scholar, a fellow of St. John's and first demonstrator under Clerk Maxwell in the Cavendish Laboratory, Dr. Garnett illustrated in his training the happy union between pure and applied science upon which the well-being, and even the security, of our national life depend. His principalship of the Durham College of Science showed how clearly he had grasped the essential principles of technical education; his opportunity of applying those principles on a large scale came with his appointment, in 1893, as secretary and educational adviser to the Technical Education Board of the London County Council. The eleven years of the board's activity must always be regarded as of momentous importance in the history of London education. Polytechnics sprang into being or were revivified, a clearly conceived system of central and local technical institutes materialised, the conditions of science teaching in secondary schools were enormously improved, and the scientific and technical work of the University was greatly stimulated and aided. The hand of Dr. Garnett was plainly visible in all these good works, and they will be his enduring monument.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, November 26.—Dr. A. Russell, vice-president, in the chair.—J. **Guild**: Obtaining and maintaining a bright hydrogen spectrum, with special reference to the 4341 line. The paper treats of the conditions of pressure, discharge, etc., most suitable for the production of a bright hydrogen spectrum, such as is required for refractometry and similar purposes. The rapid deterioration of the tubes with use is shown to be caused by a rise of pressure due to the evolution of hydrogen by the electrodes. The trouble may be obviated by sealing an auxiliary bulb of $1\frac{1}{2}$ or 2 litres capacity to the discharge tube. This reduces the rate of pressure variation and prolongs the useful life of the tube nearly a hundredfold. The use of capacity and inductance is shown to be very helpful with partially deteriorated tubes.—A. **Griffiths**, J. M. **Dickson**, and C. H. **Griffiths**: The determination of the coefficient of diffusion of potassium chloride by an analytical method. This paper represents an attempt to develop an analytical method of determining the coefficient of diffusion of a salt in water capable of giving consistent and accurate results. The lower ends of a number of vertical and parallel diffusion tubes terminate in a reservoir of large capacity containing a solution of potassium chloride. The greater part of the reservoir is above the lower ends of the tubes, and by gravity the solution at the lower ends is kept at an approximately constant concentration. The upper

ends of the tubes are covered with a cap provided with an outlet and an inlet tube. Water enters the cap by the inlet tube, and a weak solution containing the diffused salt leaves the cap by the outlet tube. Time, which may be as long as a fortnight, is allowed for the attainment of the steady state, and an individual experiment may last six weeks. The quantity diffused is obtained by chemical analysis. In the case of a solution containing 0·2237 gram of potassium chloride to the cubic centimetre (a 3N solution) the "mean diffusivity" with respect to water is $1{\cdot}703 \times 10^{-5}$ (C.G.S. units) at a temperature of 18·5° C.

Royal Astronomical Society, December 10.—Prof. R. A. Sampson, president, in the chair.—H. H. **Turner** and Miss **Blagg**: Baxendell's observations of variable stars; continuation, including T Herculis, R Leonis, and S Orionis.—F. A. **Bellamy**: The number of faint stars with large proper motions in zone +29°, and on the accuracy of Hagen's chart of variable stars.—H. H. **Turner**: Ninth note on the astrographic magnitude scales: the Toulouse and Cape magnitudes, with further remarks on the obscured patch in the sky, considered as a spiral. The data for the southern hemisphere were unfortunately very incomplete, as there is a gap in the observations between −1° and −31°.—J. H. **Jeans**: The theory of star-streaming and the structure of the universe. Various hypotheses were considered, and it was concluded there is no hope of unravelling the mechanism of the universe by assuming that it is in a steady state, or of using the observed phenomena of star-streaming for exploring its structure.—J. H. **Reynolds**: Photographs of Jupiter, taken in November with the 28-in. reflector.—G. E. **Hale**: Spectroheliographs of a remarkable disturbed region of the sun, August 7, taken at the Mount Wilson Solar Observatory, California.—W. H. **Wright**: Series of photographs of the spectra of nebulæ taken at the Lick Observatory. It was hoped that they would assist in a proper classification of nebulæ by their bright-line spectrum. The nuclei of most nebulæ stood high on the temperature scale, and red stars are not associated with nebulæ. An important circumstance was the appearance in the spectra of lines of carbon and nitrogen.—H. C. **Plummer**: The distribution of stars in globular clusters; and on the motions and distances of the bright stars of type F. In the latter investigation the author was greatly assisted by a table of stellar motions in equatorial co-ordinates, and other data, for stars of type F, by Mr. O. R. Walkey.

CAMBRIDGE.

Philosophical Society, November 22.—Prof. Newall, president, in the chair.—Prof. **Hughes**: Notes on oysters, recent and fossil. The author exhibited and described a large collection of recent and fossil oysters, pointing out how the modification of shape to suit changing conditions, as observed in recent specimens, suggested explanations of the evolution of species, in accordance with environment, among similar fossil forms.—Dr. **Marr**: Fossil zones and geological time. An attempt is made to estimate the time required for the accumulation of the fossiliferous rocks by taking the case of the chalk, comparing its rate of accumulation with that of the modern globigerinous ooze, and then calculating the number of fossil-zones in the chalk and in the whole of the fossiliferous strata. The result obtained suggests a minimum period of not fewer than 21,000,000 years for the formation of the fossiliferous strata. The controlling factors are too uncertain to permit much stress to be laid on this estimate, which is probably much too low, but according to it the evolution of organisms from the beginning of Cambrian times onwards need not have occupied a period of time greater than that which on various grounds is granted to geologists by followers of other sciences. The method may be applied with nearer approximation to accuracy, in estimating the relative importance of different groups of strata; thus the number of zones in Palæozoic and Mesozoic rocks respectively indicates that the period during which the former were being laid down was not necessarily much longer than that required for the accumulation of the latter.—H. B. **Fantham** and Miss Annie **Porter**: Induced herpetomoniasis in birds. All the great classes of European vertebrates, except birds, have been infected by the authors previously with flagellates found in various insects. Results are now given of some experiments in which birds have been similarly infected. Herpetomoniasis can be induced in birds, for example, canaries (*Serinus canarius*), sparrows (*Passer domesticus*), and martins (*Chelidon urbica*) by feeding them on insects containing herpetomonads, or on food contaminated with insect fæces containing herpetomonads. *Herpetomonas culicis* from the gnat, *Culex pipiens*, and *H. jaculum* from *Nepa cinerea*, have fatally infected birds when fed to them. Both flagellate and non-flagellate herpetomonads have been found in the internal organs of the infected hosts. The cycle of the flagellates in the avian hosts resembled that in the insects. Members of all classes of vertebrates may be capable of acting as reservoirs of herpetomoniasis, and the virus may exist in a very attenuated condition and so be difficult of detection.—H. B. **Fantham** and Miss Annie **Porter**: Notes on certain Protozoa which may be found in cases of dysentery from the Mediterranean war zone. The authors dealt briefly with the morphology and life-histories of *Entamoeba histolytica, E. coli, Trichomonas hominis, Chilomastix* (*Tetramitus*) *mesnili, Giardia* (*Lamblia*) *intestinalis* and *Balantidium coli.* The pathogenic actions of these parasites were discussed. Various preventive measures, the occurrence of carriers and of reservoirs were indicated. The modes of treatment successfully used by recent workers were mentioned.—Dr. **Arber**: A little-known concealed coalfield in Oxfordshire. The results of the Burford and Batsford borings appear to show that, in this concealed coalfield, the Coal Measures are red-grey productives, probably belonging to the Transition Coal Measures. These beds overlie Silurian rocks. The measures appear to be related to those of the Newent and Wyre Forest Coalfields, both lithologically and as regards horizon.

PARIS.

Academy of Sciences, November 29.—M. Ed. Perrier in the chair.—The President announced the death of Charles René Zeiller.—Maurice **Hamy**: The determination of radial velocities with the prism objective. In a preceding communication a method was sketched for the determination of the radial velocities of stars, making use of a prism objective. Detailed calculations are now given.—H. **Douvillé**: The Orbitoids: their development and embryonic phase. Their evolution during the Cretaceous period.—M. de **Séguier**: The equations of certain linear groups in a Galois field.—M. **Pigeaud**: The elastic equilibrium of an indefinite plate of uniform thickness, compressed by two equal and opposite forces, uniformly distributed along two parallel right lines situated in a plane normal to the bases.—Œchsner **de Coninck** and **Gerard**: The atomic weight of cadmium. Details of the method employed for the purification of the commercial cadmium are given. The experimental ratio determined was cadmium oxide from cadmium carbonate, and the mean of five determinations was 112·32, as against the atomic weight adopted by the International Commission, 112·40.—O. **Bailly**: The mechanism of the action of the tribasic sodium phosphate on the α-mono-

chlorohydrin of glycerol.—E. A. **Martel**: The contamination of subterranean waters as a consequence of the war. An example is given of contamination of a water supply persisting for a whole year, and the necessity of special precautions in maintaining the purity of potable water is pointed out. It must not be taken for granted that after a certain lapse of time processes of self-purification are sufficient.—J. **Bergonié**: A new method of surgical radioscopy in red light.—A. **Renault**, L. **Fournier**, and L. **Guénot**: Five hundred and fifty cases of syphilis treated by an organic compound of arsenic, silver bromide, and antimonyl. Further experiments on treatment of syphilis with the compound proposed by M. Danysz under the name of "102." It has the special advantage that there is a wide range between the parasitic dose and the toxic dose. The therapeutic effects are comparable with those of arseno-benzene. The preparation possesses great stability, the treatment is simple and without danger, and extremely efficacious.

BOOKS RECEIVED.

A Text-Book of Inorganic Chemistry. Edited by Dr. J. Newton Friend. Vol. viii.: The Halogens and their Allies. By Dr. G. Martin and E. A. Doncaster. Pp xviii+337. (London: C. Griffin and Co., Ltd.) 10*s*. 6*d*. net.

The British Warblers. By H. E. Howard. Two vols. (London: R. H. Porter.) 10*l*. 10*s*. net.

The Book of Matriculations and Degrees. Pp. xvi+315. (Cambridge: At the University Press.) 12*s*. 6*d*. net.

Memoirs of the Queensland Museum. Vol. iv. Edited by Dr. R. Hamlyn-Harris. Pp. 365. (Brisbane: A. J. Cumming.)

Submarines: their Mechanism and Operation. By F. A. Talbot. Pp. x+274. (London: W. Heinemann.) 3*s*. 6*d*. net.

Archaic Sculpturings. By L. M. Mann. Pp. 52. (Edinburgh and London: W. Hodge and Co.) 2*s*. 6*d*. net.

Roald Amundsen's Antarctic Expedition. Scientific Results: Meteorology. By H. Mohn. Pp. 78. (Kristiania: H. J. Dybwad.)

Rural Sanitation in the Tropics. By Dr. M. Watson. Pp. xvi+320. (London: J. Murray.) 12*s*. net.

Ticks. Part ii., Bibliography of the Ixodoidea II. By Prof. G. H. F. Nuttall and L. E. Robinson. Pp. 32. Part iii., The Genus Hæmaphysalis. By Prof. G. H. F. Nuttall and C. Warburton. Pp. xiii+349–550+plates viii–xiii. (Cambridge: At the University Press.) 4*s*. 6*d*. net and 12*s*. net respectively.

Carnegie Endowment for International Peace. Year Book for 1915. Pp. xvii+177. (Washington, D.C.)

My Growing Garden. By J. H. McFarland. Pp. xiii+216. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 8*s*. 6*d*. net.

Transactions of the Royal Society of Edinburgh. Vol. li. Part i. (No. 4): The Temperatures, Specific Gravities, and Salinities of the Weddell Sea and of the North and South Atlantic Ocean. By Dr. W. S. Bruce, A. King, and D. W. Wilton. Pp. 71–169. (Edinburgh: R. Grant and Son; London: Williams and Norgate.) 8*s*. 3*d*.

A Manual of Soil Physics. By Prof. P. B. Barker and H. J. Young. Pp. vi+101. (Boston and London: Ginn and Co.) 3*s*.

A Treatise on the Theory of Invariants. By Prof. O. E. Glenn. Pp. x+245. (Boston and London: Ginn and Co.) 10*s*. 6*d*. net.

A Voyage in Space. By Prof. H. H. Turner. Pp. xvi+304. (London: S.P.C.K.) 6*s*. net.

DIARY OF SOCIETIES.

THURSDAY, DECEMBER 16.

ROYAL SOCIETY OF ARTS, at 4.30.—The Indian Jute Industry: C. C. McLeod.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Design of High-pressure Distribution Systems: J. R. Beard.

ROYAL GEOGRAPHICAL SOCIETY, at 5.—The Nature and Formation of Sand Ripples and Dunes: W. J. Harding King.

LINNEAN SOCIETY, at 5.—The Structure and History of Play: The Floating Fen of the Delta of the Danube. Miss Marietta Pallis.—The Seed-mass and Dispersal of *Helleborus foetidus*, Linn.: T. A. Dymes.—Sample of "Figured Ebony," with Specimens of Walking-sticks Manufactured from it: B. Daydon Jackson.—The Reproduction of Protodrilus: E. S. Goodrich.

INSTITUTION OF MINING AND METALLURGY, at 8.—Influence of Heat in Cyaniding Gold Ores: E. A. Wraight.—Clay: Its Relation to Ore Dressing and Cyaniding Operations: A. W. Allen.—Wolframite Mining in the Tavoy District, Lower Burma: E. Maxwell-Lefroy.

FRIDAY, DECEMBER 17.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Engineering Colleges and the War: Dr. R. Mullineux Walmsley and C. E. Larard.

MONDAY, DECEMBER 20.

ARISTOTELIAN SOCIETY, at 8.—The Common-sense Criterion of Reality: J. W. Scott.

TUESDAY, DECEMBER 21.

INSTITUTION OF PETROLEUM TECHNOLOGISTS, at 8.—The Uralsk Province and its Oilfields: F. A. Holiday.

ROYAL STATISTICAL SOCIETY, at 5.15.

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THURSDAY, DECEMBER 23, 1915.

THE "WHEAT PROBLEM" AND SYNTHETIC NITRATES.

MANY years have elapsed and much water has flowed under the bridges since Sir William Crookes startled a heedless world by an address, delivered in his capacity as president of the Bristol meeting of the British Association, in which he drew a somewhat alarming picture of "the serious peril awaiting wheat-eaters who contentedly pursue the present wasteful system of cultivation." He stated that in his opinion under present conditions of culture a scarcity of wheat is within appreciable distance; that wheat-growing land all over the world is becoming exhausted, and that at some future time—in his opinion not far distant—no available wheat land will be left. The prediction was as doleful as the prospect was disquieting; but fortunately the remedy was comparatively simple and it was near at hand. As the president pointed out, Nature's resources, properly utilised, were ample. The remedy consisted in a more scientific cultivation and, in particular, in the application of so-called chemical manures, whereby, by moderate dressings, the then average world-yield of 12·7 bushels per acre would be increased to 20 bushels —"thus postponing the day of dearth to so distant a period that we, our sons, and grandsons may legitimately live without undue solicitude for the future."

The main contention of this address was not allowed to pass without vigorous criticism, and a year later Sir William Crookes returned to the charge with a small volume[1] in which he set out in greater fulness the data on which his conclusions were based, with, however, the depressing result that he was unable, in any material degree, to modify his estimates of the future producing capacity of the wheatfields of the globe.

The whole question is of particular interest at this present juncture, when the production and distribution of wheat have been seriously affected by the convulsion which has overtaken the world. Large areas in Europe have for a time gone out of cultivation, and other districts, as in Russia and Rumania, are precluded from bringing their supplies to the world's markets. A vast economic disturbance has resulted in an extraordinary and altogether abnormal inequality of prices. Perhaps no valid comparison is possible between a world at peace where economic causes reach their legitimate and natural effects, and a world at war when almost every economic law is broken or set at defiance. Still, it would be reassuring to know that, in spite of the forebodings to which "The Wheat Problem" gave rise, measures are being taken to dispel them. As already stated, Sir William Crookes revealed to a prospectively famishing world how it might escape the horrors of starvation. "Starvation," he said, "may be averted through the laboratory. Before we are in the grip of actual dearth, the chemist will step in and postpone the day of famine." How was he to do it? By a "dominant" manure—in this case some form of fixed nitrogen.

Now, whatever may be the real interpretation of the facts to which we have referred, or whatever the intrinsic merit of the arguments based upon them—and it cannot be said, even after the lapse of the seventeen years which have intervened since the address was delivered, that the question has been definitely settled—it is common ground that a wheat supply may be materially enhanced by the intelligent application of nitrogenous manures, one of the most important of which is sodium nitrate or so-called Chile saltpetre. This fact is universally recognised; but it is not so generally understood that the present natural sources of sodium nitrate are by no means limitless. Even now the rich beds in the rainless districts in the northern provinces of Chile between the Andes and the coast hills have been nearly worked out. It is true that when the raw "caliche," containing from 25 to 50 per cent. nitrate, is exhausted at no very distant date, there is a lower grade of material which may be worth working. But the broad fact remains, and we cannot escape from it, that the time is approaching when we must seek some other sources of supply. So far as we know, the world has no other sources of the naturally occurring product than Chile. We must therefore look to the laboratory, and we have a confident hope that the chemist will not fail us. The synthetic production of nitrates, adumbrated by a scientific use of the imagination, so far back as 1898, is now an accomplished fact and a commercial possibility. Processes are at work in various countries, and Germany, we are told, is now independent of all outside sources of nitrates, and her manufacturers have made such

[1] "The Wheat Problem." By Sir William Crookes, F.R.S. (London: John Murray, 1899.)

terms with their Government that they have been able to establish a permanent industry protected from outside competition.

In the meantime, so far as we have been able to gather, this country is doing nothing in this matter. It may be that it is incapable of doing anything, as natural conditions may be against us. But it is difficult to see why we are worse off in this respect than Germany. Energy can be produced as cheaply in this country as in Germany, if not cheaper, and the problem as a commercial matter is largely a question of cheap electrical energy. We have the same ample supply of nitrogen and oxygen in our atmosphere as Germany, and soda is at least as cheap with us.

The whole question needs systematic examination, and it is the object of this article to commend it to the careful and serious consideration of one of the scientific committees which have been established since the outbreak of war. There is surely no more pressing or important problem in the interests of the future welfare of this country, intimately bound up as it is with the prosperity of our agriculture, the oldest and most vital of our industries. We have amongst us men—chemical engineers and electrical engineers—who can deal adequately with this subject, and they could confer no greater national benefit than to enlighten the manufacturing community concerning the possibilities of the synthetic production of nitrates in this country as a commercial enterprise, after a careful and impartial consideration of all available facts.

This is a matter which intimately concerns the Board of Agriculture, and it might appropriately be considered by the Departmental Committee appointed by the president of the Board a few weeks ago "to make arrangements with a view to the maintenance, so far as possible, of adequate supplies of fertilisers for the use of farmers in the United Kingdom." We do not recognise a chemist among the members of the committee, and conclude, therefore, that the possibilities of producing a supply of synthetic nitrates are not to be contemplated. If the omission is deliberate, we suggest that the subject should be taken up by the British Science Guild, or by one of the committees recently appointed by the Government and by scientific societies, so that a definite view of our national position in this matter may be presented and provision may be made for any eventualities which the future may bring, either during the war or in later years.

THE FAUNA AND FLORA OF CENTRAL AMERICA.

Biologia Centrali Americana. Zoology, Botany, and Archæology. Edited by F. D. Godman and O. Salvin. (London: Dulau and Co., Ltd., 1879–1915.)

THE first and last volumes of this magnificent work have recently appeared, and as it is impossible to review adequately sixty-three volumes, even if one took up several numbers of NATURE, the following attempt will be confined to the first or introductory volume, which has recently been issued under the editorship of Mr. Godman.

When this great work was first planned it was estimated that the zoological part would not exceed twelve volumes of five hundred pages each, and that four volumes would suffice for Botany; the inclusion of the Archæology was not at that time contemplated. These sixteen volumes have, however, swollen into sixty-three volumes, including a most valuable contribution by Mr. A. P. Maudslay on the archæology, ruins, and inscriptions of Yucatan.

It is not unusual for a rich patron—a modern Mæcenas—to subsidise publications on an extensive and even lavish scale. It is less usual to find the patron and investigator in one and the same man, but, in fact, it is mainly due to the public spirit and the scientific ardour of Mr. Godman that this very important contribution to biological science has been so successfully carried through.

Godman and Salvin belonged to a small group of Cambridge undergraduates who, in the middle 'fifties, took a keen interest in natural history. In the neighbouring and then undrained fenland they once even chased a buzzard, and "were just too late to catch the 'large copper,' recently become extinct." These youthful naturalists were wont to meet in each other's rooms and discuss their various "finds," and, indeed, it was in Newton's rooms at Magdalene, towards the end of 1858, that Salvin, Simpson, Wolley, Slater, Newton, and others met and passed a resolution founding the Ornithological Union, the journal of which, *The Ibis,* has now reached its fifty-sixth volume.

Salvin had already travelled in northern Africa and northern Europe when in 1857 he paid his first visit to Central America, and first became acquainted with the collectors who were then active in these regions. Two years later he returned again; and two years afterwards Godman joined Salvin on his third expedition to Guatemala. Again in 1867, accompanied by his wife, Salvin returned for a fourth time to Guatemala, and after

coming back *viâ* the United States in 1875 was appointed Strickland Curator of the Bird Room in Cambridge.

Salvin's removal to Cambridge necessitated his giving up his house in South Kensington, which had served as a museum and library for the Central American collections, then very rapidly accumulating. To replace this centre a house was taken in Tenterden Street, Hanover Square, and for some years this was the home of hard work and much instructive conversation and debate, for after the scientific meetings of the Zoological Society in the neighbouring square the ornithologists frequently repaired hither to exchange views, criticisms, and ideas.

The area of the New World which is dealt with in this series of monographs "includes the whole of Mexico south of the Rio Grande as far as El Paso, and thence to the Gila river, and following it as far as the Gulf of California." Some of the neighbouring islands the sea-birds of which are common to those in the adjacent mainland are also included. The whole of Central America, comprising British Honduras, Guatemala, southern Honduras, Nicaragua, Costa Rica, and Panama, come within the area. In shape the area has been compared to a cornucopia, narrowing from the northern breadth of 1140 miles to 45 miles at the isthmus of Panama. From a climatic point of view the area is divided into three zones, the Tierra Caliente, the Tierra Templada, and the Tierra Fria, the middle term of which corresponds roughly with an elevation of 3000 to 5000 feet. But these limits vary on the Pacific and the Atlantic coasts, the greater rainfall on the latter producing a much more luxuriant vegetation than is found on the western slopes. Although the present connection between the North and South American continents is by way of the Central American isthmus, the same does not apply to the tectonic connection. Geologically, the true union of North and South America is through the Antilles, these islands being the peaks of a mountain range which forms the true link between the coast ranges of North America and the Andean chain of South America, although even this cannot be said to be a direct continuation of either of them. The isthmus, as a connecting link, is of later date, due to various complex phases of earth-movement, so that the Caribbean Sea, although now forming part of the Atlantic, was in its past history more closely bound up with the Pacific Ocean.

In the region in question, the formations consist of Tertiary deposits, fossiliferous limestones, sandstones, and clays, together with igneous rocks and ashes, these being similar to those found in the coast ranges and in the Andes. Nowhere in the Central American mountains is any pre-Tertiary core exposed, such as is found in many of the mountains of that period elsewhere. The main movements seem to have been completed by the close of the Miocene times, as Pliocene and more recent deposits are only found at comparatively low elevations, and have not been involved in the major movements. The most recent movements have given rise to the coastal plains, which are specially well marked on the Atlantic side of the isthmus.

Although Godman and Salvin between them covered in their travels but a small part of the extensive area in question, Mr. Godman has given a peculiarly complete and fascinating account of the physical feature of the "terrain," the fauna and flora of which they investigated, since the former has rightly used the field-notes and records of their numerous collectors and other naturalists who have worked in Mexico and Central America.

If we exclude the botanical volumes, and Mr. Maudslay's monograph on Archæology, we shall find the work deals in the main with Vertebrate and Insect forms, and among the vertebrate the birds especially stand out. The total number of species of Mammalia is described as 181, and as Dr. Sclater remarked:

"It may fairly be said that (excluding the introduced Mures), at least one hundred of the constituent species are essentially Neotropical in their character, or have Neotropical affinities, while of the remainder not more than sixty can be said to be decidedly Nearctic. There is, therefore, no doubt that the Central American isthmus, at any rate as far north as Tehuantepec, should be assigned to the Neotropical region."

More than 1400 species of birds were enumerated, of which nearly one-half were endemic. The Reptiles and Batrachia yielded just under 700 species.

As regards the geographical distribution of these animals, Dr. Günther remarks that:—

"A boundary line between the North and South American regions cannot be drawn. Central America forms a transition-tract, unlike any other part of the world, showing the most extraordinary diversity of climatic, physical, and meteoric conditions within comparatively small areas, favouring the evolution of a great variety of types of genera and species."

Mr. C. Tate Regan has been responsible for an admirable monograph on the Pisces. He also associates Central America with the Neotropical region.

Amongst the Invertebrates, besides the insects

mentioned already, the Molluscs form the subject of a monograph by E. v. Martens. Unfortunately the Crustacea have not been studied, the late Prof. T. H. Huxley being unable to finish the fresh-water Malacostraca, which he had hoped to describe. The Spiders, Harvestmen, Scorpions, Pedipalps, and, to a certain extent, Mites and Centipedes, have, however, been fully worked out. As is so often the case, the Beetles, which numbered more than 18,000 species, receive special notice, and indeed the Coleoptera and the Lepidoptera were the only two groups for which sufficient specialists were forthcoming to describe the collections completely. The Hymenoptera, unfortunately, have not been fully examined, and the Bees and Social Wasps have had to be passed by. The Diptera, again, yielded comparatively few species, and the same is true of the Orthoptera.

The whole world benefits by this series of stately tomes, but the debt of our country is even deeper, for all the collections brought together with so much care and cost now repose in the British Museum (South Kensington). We cannot refrain from including the following quotations in this short notice:—

"All the insects from Mexico and Central America, the Sallé and Janson collections of beetles, our own general collection of birds and butterflies, and the Henshaw collection of birds, have been presented by us to the British Museum, and are being gradually incorporated with the National Collection."

"The various accessions are enumerated in detail in vol. ii. of the 'History of the Collections contained in the Natural History Departments of the British Museum' (1906), and in the subsequent annual reports of that Institution. The first instalment of Neotropical birds (50,120 specimens) was presented in January, 1885, and other instalments followed from time to time until the whole of them became the property of the nation. Amongst the insects, up to 1906, the total number of specimens given in the 'History' is as follows; Coleoptera (85,920), Lepidoptera Rhopalocera (17,829), Lepidoptera Heterocera (12,883), Diptera (17,525), Hymenoptera (10,004), Rhynchota Heteroptera (5543), etc. These figures do not include the Rhynchophora or weevils (22,793), the Staphylinidæ and water-beetles (9474), the Odonata (3000), the Rhynchota Homoptera (5509), the supplementary unworked parasitic Hymenoptera (6293), etc. From 1906 onwards the remaining collections have been handed over to the Museum as soon as the enumeration of the species was completed; that of the Coleoptera was finished in 1911. Our own general collection of butterflies probably included nearly 100,000 specimens, and the beetles alone from Mexico and Central America perhaps double that number. Besides these a considerable number of mammals, reptiles, fish, etc., of which no account was kept, were presented to the National Museum."

The "Biologia Centrali Americana" must ever remain a classic. Biological science owes a deep debt to those who planned, designed, financed, and carried out this truly monumental work. In every sense of the word it is a credit to the British nation, and we only wish that Mr. Salvin had lived to share with his collaborator the widespread recognition of the great services they have rendered to their science and to their country.

FOSSIL MAN.

The Antiquity of Man. By Prof. A. Keith. Pp. xx + 519. (London: Williams and Norgate, 1915.) Price 10*s.* 6*d.* net.

THE chief works on the antiquity of man have hitherto been written by geologists and archæologists. Prof. Keith now treats the subject from the point of view of the human anatomist. The available facts and speculations of geology and archæology are all briefly stated and introduced at appropriate stages in the argument; but the anatomical characters of the various known human remains and their significance form the author's main theme. The plan has obvious disadvantages, for the value of the conclusions depends on the authenticity of the materials, which none but an expert geologist can determine. It also fosters a tendency to make dogmatic statements about the age of the various remains in terms of years, which may please a section of the inquisitive public but cannot be admitted as science. At the same time, the human anatomist is an essential factor in unravelling the story of primitive man, and Prof. Keith has produced an important work, which is all the more fascinating since it is the direct outcome of his own personal observations.

The great interest of Prof. Keith's volume, indeed, depends on the insight it affords into the methods and aims of modern research in prehistoric anthropology. It is sometimes technical and tedious, but the whole is written with the inspiring enthusiasm of an investigator, and it is enlivened by many personal touches when describing the circumstances of the different discoveries. The general reader will also be much helped in the comparison of the human skulls and jaws by the author's method of placing his numerous figures in rectangular frames of standard size.

Prof. Keith begins with the long-headed men of Neolithic times, and observes that they exhibit no primitive features in their skeleton. He de-

scribes the circumstances in which undoubted Neolithic remains were found in the megalithic monument of Coldrum, Kent, and then deals with several other examples, including the famous Tilbury skeleton, which he refers to the beginning of the Neolithic period. He next considers some of the well-attested human remains from the latest Palæolithic deposits, such as the skeleton from Paviland cave, Glamorganshire, and the well-known skulls from Engis, near Liège, and from Cromagnon in the Dordogne valley, France. These also are shown to agree with the corresponding parts of existing European man; though certain skeletons found in the Grimaldi caves, near Mentone, which seem to belong either to the same or to a closely-allied race, differ a little from all European skeletons, and exhibit some negroid features. In the skulls, however, the right and left eminences of the forehead are not fused together into a peculiar single boss as is the case in typical negroes. Prof. Keith therefore thinks that the Grimaldi type may, perhaps, be most nearly represented in the modern world, not by negroes but by the tall races of the Punjab, India. He also assigns to the late Palæolithic period a skeleton from Halling, Kent, skeletons from the Cheddar caves and Cissbury, a skull from a cave at Langwith, Derbyshire, and other fragments about the age of which geologists are by no means agreed. None of these remains exhibit any essential differences from modern English human skeletons, and it is very uncertain how many of them have been introduced into Palæolithic deposits by comparatively recent burial. Prof. Keith, indeed, soon proceeds to forfeit confidence in his conclusions by the dogmatic manner in which he accepts remains of doubtful authenticity, such as the much-discussed skeletons from Galley Hill (Kent) and Ipswich. He even states that he regards the Palæolithic age of the Galley Hill skeleton as a certainty (p. 250). No geologist would do more than place such remains in a "suspense account," and the majority would probably ignore them altogether.

The concise chapters on Neanderthal man give an excellent summary of the latest researches on this strange extinct species, and Prof. Keith is now of opinion that he cannot be included in the direct ancestry of modern man. The massive mandible of Heidelberg man is considered to represent "a primitive variety" of the Neanderthal race. Evidence of fossil man from Africa and Asia is described as disappointing, but Pithecanthropus is considered to be one of the Miocene types of ancestral man which survived to a later date on the island of Java.

After a brief reference to the unsatisfactory nature of the discoveries of fossil man in North and South America, Prof. Keith devotes the remainder of his volume to an extended discussion of the skull and mandible of Piltdown man, or Eoanthropus. This discussion, in fact, is so extended that it tends to become discursive, and to obscure whatever conclusions it is intended to convey. It is only evident that when the remains of an extinct genus of Hominidæ are to be interpreted, the experience of a vertebrate palæontologist is needed to supplement and modify the ordinary methods of the human anatomist. Prof. Keith has now so altered his first restoration of the Piltdown cranium that the brain-capacity is reduced to about 1400 c.c., while the mandible has become essentially identical with that reconstructed by Dr. Smith Woodward. In his Figs. 176 and 185 he even shows the upstanding large lower canine tooth being worn by the upper canine, although on p. 459 he still maintains that the wearing must have been due to the upper lateral incisor. Mr. Charles Dawson's discovery of Eoanthropus, however, has raised problems of such difficulty that differences of opinion as to its interpretation will continue until less imperfect remains are forthcoming; and all students will welcome Prof. Keith's detailed statement of the questions involved. As to his more general conclusions in the final chapter of the book, geologists and palæontologists at least will hesitate to accept them on account of the doubtful nature of much of the evidence on which they are founded; but all will realise their indebtedness to Prof. Keith for an inspiring new view of an old and perplexing subject.

A. S. W.

THE WAR AND THE FUTURE.

The War and After. Short Chapters on Subjects of Serious Practical Import for the Average Citizen in A.D. 1915 *Onwards.* By Sir Oliver Lodge. Pp. xiii+235. (London: Methuen and Co., Ltd., 1915.) Price 1*s*. net.

THE little volume which Sir Oliver Lodge has written is of interest from more than one point of view. The author frankly confesses that he has "no pretension to be an historian"; and in the first section of his book he has borrowed from many authors in order to present a picture of "The Past." The result is, to some extent, a patchwork; but the quotations are skilfully dovetailed into the text, so that the general effect is not so uncouth as might be feared. The second portion of the book, "The Present," deals with problems such as those presented by aggressive and defensive wars, savagery, pacifism, material prosperity, and self-

interest; and here the book has more direct bearing upon present-day affairs.

The average reader will turn with most interest to the third section, "The Future"; and in it he will find much to stimulate thought. It would be too much to expect a general agreement with all the views advanced by the author; but whether one differs from him or not, his book will serve a useful purpose in compelling people to think out certain problems which must arise before many months have passed. Sir Oliver Lodge is frankly an optimist; but his optimism does not blind him to the difficulties which will lie before this country when the war is over. He discusses the question of social unrest, traces its roots in the present industrial conditions, and suggests one or two points at which improvements might be made; but the limited space at his disposal has obviously led to a curtailment of this part of the book. He asks that science shall not be forced "to grub along like a sort of Cinderella, called in occasionally when the housework has to be done, but otherwise left to sit among the ashes and brood"; but the turn of his phrases seems to hint that, like most of us, he has little hope of any immediate improvement in this direction.

Apart altogether from its subject-matter, the volume is interesting as a revelation of the feelings of one of the older generation. Sir Oliver Lodge is clearly one of those who were well acquainted with "the lovable, friendly, and homely past aspects of the majority of our present foes"; and, lulled by these recollections, he failed to notice that the modern German has but little resemblance to his forefathers. Naturally the revelations of the war have shocked him, and he strives pathetically to readjust his views. He is plain-spoken in his indignation at the methods employed by the Germans in the campaign; but when he comes to the question of the settlement after the war, there appears, not too vaguely, the firm belief that madness will depart and leave us once more with the kindly Germans of his earlier recollections.

Sir Oliver Lodge's conclusions may or may not be right, and it certainly seems to be risking a good deal upon a gambler's chance. The essential condition of peace is the security of Europe for the next generation; and if the German people emerge from their ordeal in a better frame of mind it will be all to the good; but it would be criminal to leave them with their teeth undrawn merely on the chance that they might re-acquire the old characteristics which they have evidently lost. It is no use telling us that "an enormous amount of what they are committing just now has nothing to do with their soul." A nation whose soul is so aloof from "what they are committing" might just as well have no soul at all. The matter cannot be shuffled off on to the back of Prussia alone. The criminal statistics of Germany before the war were a sufficient danger signal; and, as to the South German type, the Bavarians had a bad reputation in 1870, and have gained a worse one during the present campaign. One may regret the past, in common with Sir Oliver Lodge, but it is useless to blind ourselves to the fact that we are dealing with a different kind of nation to-day.

OUR BOOKSHELF.

Soils: their Properties and Management. By Prof. T. L. Lyon, Prof. E. O. Fippin, and Prof. H. O. Buckman. Pp. xxi+764. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1915.) Price 8*s*. net.

PROF. LYON has done well to bring together his colleagues in the well-known school of soil technology at Cornell, and induce them to join in producing a book on soil management. The result is eminently successful, and will be cordially welcomed by all teachers and students of agricultural science.

Beginning with the general principles of soil formation, the authors pass, naturally, to the actual soils of the United States, and reproduce for this purpose the interesting soil map published two years ago by the Bureau of Soils. From the soil as a mass they proceed to the separate particles, dealing first with chemical and physical properties, and then with the relationships to water and temperature. Afterwards they turn to the micro-organisms of the soil, and finally to the methods of soil management—methods by which the soil conditions can be made more favourable for the growth of plants.

The distinguishing feature of the book is the extensive use made of the results of recent investigations in the United States, in this country, and on the Continent. On reading the book one is struck by the great advance made by soil investigators during the past ten or fifteen years. New points of view, new fields of knowledge, and new methods of investigation have all been opened up, and the various results are beginning to piece together remarkably well. Altogether the outlook is very hopeful, and if only soil investigators could find an elegant name for their subject they would soon be assured of an enthusiastic following.

E. J. RUSSELL.

The Cures of the Diseased in Forraine Attempts of the English Nation. London, 1598. Reproduced in facsimile, with introduction and notes by C. Singer. Unpaged. (Oxford: At the Clarendon Press, 1915.) Price 1*s*. 6*d*. net.

THE short tract now published in facsimile by the Clarendon Press was written by one George Wateson, doubtless George Whetstone, the

Elizabethan playwright. Hakluyt, in the dedication to Sir Robert Cecil of the third volume of his "Voyages," refers to this tract, and says that he showed it to Dr. William Gilbert, Queen Elizabeth's physician, who found it "very defective and imperfect."

The tract is but twenty pages, on the nature, diagnosis, and treatment of some of the infections which most heavily scourged seafaring men in the tropics in Elizabeth's time—yellow fever, dysentery, erysipelas; something also on heat-stroke, prickly heat, and scurvy. We must not despise it for its brevity; it is just a tract for men in the tropics; just the beginning of "tropical medicine"; a childish thing, but commendably free from superstition and magic. The account of scurvy is vivid and practical, and the short introduction and notes by Dr. Charles Singer are admirably written and full of authority.

It is a strange feeling to have in one's hands, in facsimile, the first English treatise on tropical medicine. So many things have been discovered since 1598. It was published two years after Drake's death, at Porto Bello, of dysentery. Whetstone, in his dedication of the treatise to the Queen, says that he is writing from experience. "In my injust imprisonment in Spayne, it pleased God to afflict me with the Tabardilla Pestilence: whereof being in cure, by an especiall Physition of that King, I observed his methode for the same, and such other Diseases, as have perished your Maiestie's people in the Southerne parts."

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Organisation of Science.

I WONDER whether other readers of NATURE besides myself caught the interference fringes from three facets of this glittering subject in the issue of December 2? The first was the Royal Society's advertisement for applications for grants for scientific investigations from the Government fund; the second, the editorial contrast between the rates of pay for legal and for scientific services; and the third, the anniversary address of the president of the Royal Society, containing the suggestion that science does not take its place in the national organisation because the general public looks upon scientific investigation as a hobby.

What else can the general public do while men of science, in dealing with one another, generally act upon the principle that scientific investigation is a hobby for which facilities are required, not payment? The demonstration afforded by the Government Grant Committee and the Committee of Recommendations of the British Association is conclusive. The normal practice is for these committees to be asked to supply a portion—rarely the whole—of the expenses of some scientific investigation. The applicants in reply to the advertisement will think it meritorious to offer their brains and the time required to use them without asking for any payment. That is the true criterion of a hobby. So great is the power of science to transform serious occupations into hobbies that even lawyers sometimes find themselves astride and ambling with the rest.

In justification of the scientific societies, it may fairly be said that they were intended for the riding of hobbies, and everything in their constitution and practice conforms with that eminently useful ideal. Scientific societies rely very largely upon unpaid work, and long may they continue to do so. One of their chief attractions is that within their precincts there is a respite from the wearing obligations of debit and credit. One cannot find the like about a law court or a house of business, where as a rule those who are paid most are treated with the highest respect.

It is the difference between hobby and business that brings us to the parting of the ways. If the national scientific effort is organised through the agency of societies where all the best work, even by the officers, is done without any regard to payment, we cannot expect the public to look upon science as a business into which pecuniary considerations enter. It is, and must remain, a hobby. If, on the other hand, there should be created a Privy Council for Science, as Sir William Crookes suggests, there would be at least a permanent staff to whom the idea of paying for brains and time would not be fundamentally repugnant as it must be to the officers of a society.

The idea of scientific investigation as a hobby does not necessarily originate with the general public; it is indigenous in the older universities, where there are a large number of college officials intellectually competent to undertake researches, some of whom do and some do not. At Cambridge in my time scientific investigation was the occupation of the leisure of men whose maintenance was provided by the fees and emoluments of teaching. It was as much a hobby as chess or photography. There was no sense of collective responsibility for providing the nation with answers to its scientific questions. Scientific researches had become an element of competition for rewards of various kinds, and some "research students" were paid; but the idea of "making a living" by scientific investigation never reached the surface, though the merit acquired by research might weigh in the appointment to a post for teaching or administration. On the contrary, the early agitation for the endowment of research was regarded as finally disposed of by calling it the research of endowment, as though the wish to be paid were conclusive evidence of insincerity.

The suggested council will have some difficulty in organising adequately paid research. The endowed researcher in the national interest must expect an occasional audit of an imperious character, and his employers must see their way to act upon it. With teaching the difficulty is less. If the students of one year do not respond, the next year may be more successful. It takes just about a lifetime to satisfy ourselves about our own weaknesses. The responsibility is nicely divided; it is just as much the duty of the students to learn as of the lecturer to teach, and neither student nor teacher has the material for a considered judgment upon the matter. That is why the "hobby" system, with occasional rewards for exceptional success, is so popular. It can be worked best by letting things go their own way.

The present state of things, which all agree in deploring, can be altered by drawing a clear distinction between a society's hobbies and the nation's purposes, and entrusting them to separate administrative management. Mr. Carnegie has made it clear that the financial detachment of a voluntary society is not essential to the successful organisation of scientific research.

F.R.S.

NOTES ON STELLAR CLASSIFICATION.

The Temperature Curve.

IN the first article under this title—NATURE (November 12, 1914), and Bulletin 1 of the Hill Observatory—I referred specially to the temperature curve, and pointed out that "to secure simplicity I represented the two arms of equal inclination," and to save space I used a narrow angle between them. I went on to add that by all analogy the descending arm should fall less rapidly than the ascending one rose. The analogies to which I referred dealt with the well-known curves representing the various changes in the light of new stars and of such variable stars as Eta Aquilæ, to deal with one the light curve of which has been previously given in these notes.

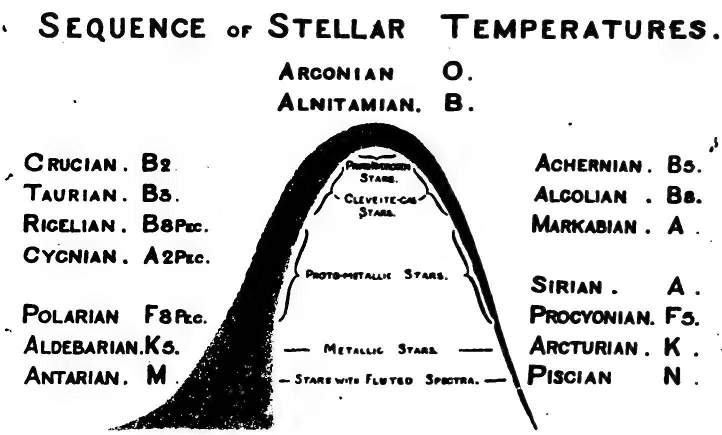


FIG. 1.—The difference in the two arms of temperature curve.

The only differences in the two arms I felt myself justified in showing were the nebulous condition in the ascending arm and the condensed condition in the descending one.

On my hypothesis the life of a star consists first as an increase of temperature due to collisions in a condensing nebula; then, after the apex of temperature has been reached, the gradual cooling down of a mass of gas and vapour.

If we can deal with a large number of stars, the true outline of a generalised temperature curve should be placed before us in considering the numbers of stars of the various groups, because the longer a star remained at about the same temperature the larger would be the number of stars in that group; and if the rise of temperature were very rapid, this would be indicated by a considerable reduction in the numbers.

My recent publication of a catalogue of the spectra of 354 of the fainter stars, combined with my previous catalogue of 470 of the brighter ones, has enabled me to test this method of inquiry.

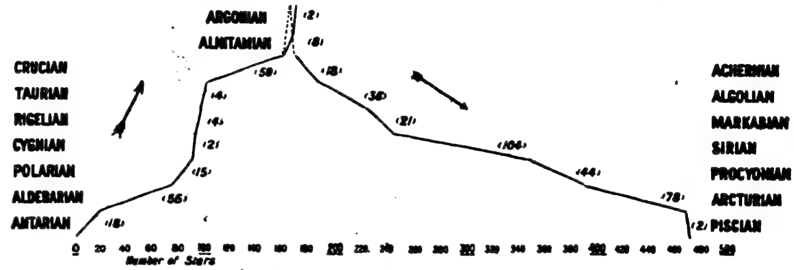


FIG. 2.—Temperature Curve based on the number of stars in each spectral group in the catalogue of 470 brighter stars.

Although the number of stars in each catalogue is comparatively small, it is perhaps large enough to average the results fairly; and as we can deal with two catalogues based on the same scheme of classification under as nearly equal conditions as possible, the comparison of the results obtained in both cases should show us, if they are similar, that the base of inquiry is a firm one; and if minor departures from similarity arise between the results obtained from the brighter and the fainter stars, we may be enabled to gather some important conclusions from the similarities or dissimilarities of the two curves. The illustrations given show how far this inquiry has already gone. In Fig. 2 the numbers of stars in each group of the 470 brighter ones are indicated by the figures shown opposite each group, on a base line the length of which is determined by the numbers of stars. In Fig. 3 the same process is followed in the case of the fainter stars, the length of the base line equally representing the number of stars dealt with.

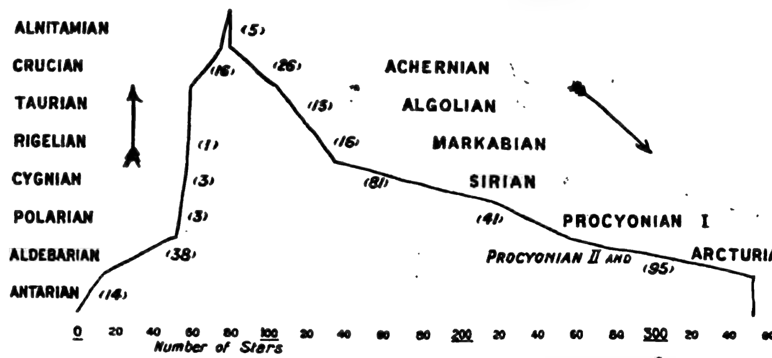


FIG. 3.—Temperature Curve based on the number of stars in each spectral group from the list in Bulletin III. Numbers in brackets show the number of stars in the separate group.

It will be seen that there is a very general likeness between the curves of the brighter and fainter stars, and to bring this out more clearly

in the fourth diagram I have brought the observations to the same scale by dealing with percentages instead of the actual number of stars as a base line. In both cases it will be seen that the shape of the curve is in harmony with the analogy to which I referred, and I think I am justified in adding that since the curves are so similar, although they have been obtained from such different sources, not only is the method of inquiry amply justified, but the principles on which the stars have been classified and separated into the various ascending and descending groups are shown to be fundamentally sound. This, of course, goes to strengthen my main contention that the life-history of a star is a rise, followed by a fall, of temperature.

Further inquiries are necessary before all the conclusions to be drawn from a comparison of the two curves can be arrived at, but some are already suggested

One point on which information might be expected from the method under notice is an indication of the various maximum temperatures attained by the individual stars. If all the stars reached the highest temperature we should expect a broader apex in the average result than if the number were restricted. A first glance at the composite curve shows that the number at the highest temperature is very much restricted. We are justified, therefore, in suggesting that those groups containing a relatively larger number of stars represent the highest temperature condition of a larger number. On the other hand, the nearly perpendicular part of the curve in the middle of the ascending side as contrasted with the slowly descending curve on the descending side indicates the action of a rapidly increasing temperature in the former. The kinks in the ascending curve, therefore, at the Aldebarian and Crucian stages of both groups of stars possess great interest from these points of view.

When a larger number of stars have been classified, and further evidence is afforded that we are absolutely dealing with homogeneous groups, this average temperature curve may help us in the study of masses and densities. We should expect, for instance, that the probable inclusion of solid meteorites in stars classified in the lower part of the ascending curve give rise, in some cases, to large masses, while on the opposite side of the curve we should expect densities above the normal.

Since my classification is based upon absorption phenomena, the curves do not include the stars in which bright lines alone have been studied, but I am continuing my inquiries concerning them, and it looks as if they will ultimately be found to represent special classes of nebulæ—that is, swarms in which something besides an ordinary condensation is taking place.

I have already shown (NATURE, February 4, 1915, and 2nd Bulletin of the Hill Observatory) that the stars with constant bright lines added to absorption phenomena occur near the top of the temperature curve.

I have to thank Mr. H. E. Goodson, A.R.C.Sc., assistant at the Hill Observatory, for the preparation of the curves.

NORMAN LOCKYER.

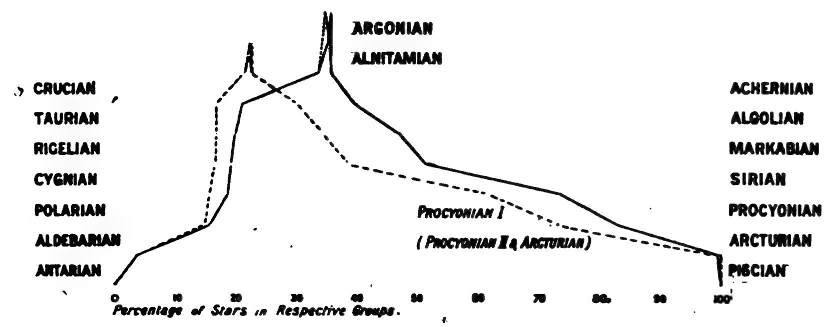


FIG. 4.—Temperature Curves based on the percentages of stars in the separate groups in "Bulletin III. and "470 Catalogue."

——— Stars in "Catalogue of 470 Brighter Stars."
...... Stars in list in "Bulletin III."

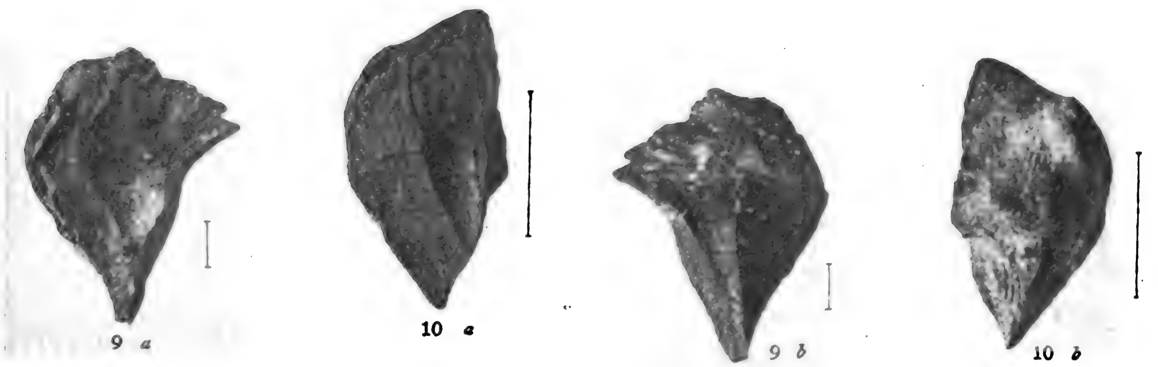
A PLIOCENE FLOTSAM.[1]

BOTANISTS expect from the authors of this instalment of the results of their sustained investigation of the Pliocene vegetable deposits of the delta of the Rhine, then much more extensive than now, work of a high standard. Those who may be led to study the work before us will find that this standard has been fully sustained, and will be left in doubt whether to admire most the care and patience in the examination and arrangement of their material to which the text and the plates which illustrate it bear testimony, the clearness with which their evidence is tabulated, or the caution and restraint with which their conclusions are formulated.

We are already indebted to our authors for various contributions to our knowledge of similar deposits associated with the brick-earth of Tegelen on the Meuse, and in that case they have been able to show from other evidence that the deposits in question are, at least approximately, contemporary with the Norwich Crag, and perhaps in part with the somewhat more recent forest-bed of Cromer. The present instalment deals with material from an older horizon, belonging to the middle, not the upper Pliocene, obtained from brick-clay pits near Reuver and Swalmen, and some distance further south at Brunssum, and the circumstance that, owing to the lack of collateral evidence, it is impossible yet to suggest a corresponding formation west of the North Sea, in no way detracts from the interest which their results arouse.

[1] "Mededellingen van de Rijksopsporing van delfstoffen." No. 6. "The Pliocene Floras of the Dutch-Prussian Border." By Clement Reid and Eleanor M. Reid. Pp. 178+xx plates. (The Hague: Institute for the Geological Exploration of the Netherlands, 1915.)

A careful examination of this paper by those familiar with the physical features of a deltaic country, such as Bengal, will induce the conclusion that the conditions under which the deposits discussed in it with such critical insight were accumulated, must have resembled those which prevail there now. Behind the alluvial "shoot" which forms the seaward edge of the delta the partially subaerial tract is broken by a network of distributaries into many low islands, the margins of which, being river-banks, rise slightly above the land within. Towards the sea these islands are stretches of mud partially clothed with salt-scrub or mangrove, or of sand with a fringing sea-fence of screw-pine and other beach-plants. Further back the mangrove swamp merges into a littoral forest, which extends as far as the tides flow salt, and clothes the islands throughout. Still further inland, where the rivers when in flood are not saline, their banks alone carry forest, the lower ground behind making a stretch of marsh when the streams are low, fresh-water lagoons when they run full.



9 *a*, *b*, *Hakea angulata.* Follicle, inside and outside. 6/1 Brunssum. 10 *a*, *b*, *Hakea saligna.* Follicle, inside and outside. 2/1 Recent. From "The Pliocene Floras of the Dutch-Prussian Border."

The contour of these islands constantly alters. The heavy flow in the larger channels may erode the shore on which the current impinges. The bank may be breached, the stream change its course, an island be cut in half, and only a line of mortlakes and marshes be left to mark the abandoned river-bed. More often, however, the root-system of the riparian vegetation keeps the bank unbroken, and the current only undermines. At flood-fall the sapped bank, deprived of the support which the water-pressure supplies, may sink into the channel, its coat of forest still intact. Submersion during the next flood-season kills the half-drowned trees. But they remain as a groin-like obstruction which deflects the current and induces a similar attack on the opposite bank further down stream. Coincident with such erosion is a compensating shelving accretion on the eddy-side of the eroded reach. Such newly-formed banks become clothed with grass and sedge which protect the surface, arrest silt, and become littered with a jetsam of fruits and seeds. From these arises an extension of the riparian forest, just as from the jetsam of the sea-face come the beach-fence and the flora of the mud-flats.

The flotsam has another and more varied fate. Much of it reaches the sea, to be swept by shore currents into a mass, many square miles in extent, sufficiently compact to impede the course of sea-going steamers, which accordingly avoid it. Before becoming so water-logged as to sink, most of this flotsam undergoes disintegration. Much, however, when the streams are full, is floated beyond the river-banks into the lower land behind. Within the area where the lagoons are emptied at every tide many of the fruits and seeds, arrested while fresh, germinate and help to clothe with forest the surface of the islands involved. But throughout the more inland area, where the flooded streams pond back their overflows for nearly half the year, such fruits and seeds as pass beyond the banks float on the surface of the lagoons among their water-weeds, to be deposited, their vitality lost, in the mud of the marsh which remains when the streams subside. The ensuing flood overlays them with silt and converts them into an organic deltaic deposit.

That the Reuverian one here described may have been the flotsam of such a fresh-water marsh-lagoon seems probable from several circumstances. There is nothing littoral in its composition, and the species which go to compose it, other than those like Nelumbium, Euryale, Trapa, Cladium, Dulichium, which were probably denizens of the actual site, may conceivably have grown on the higher ground between the lagoon and the stream, or have been water-borne from the uplands of the catchment areas of the rivers concerned. As in the Gangetic delta fruits and seeds are found west of the Baleshwar which can only have come from Upper India, east of that channel which must have come from Assam, so in the Reuverian deposits a difference is perceptible in the constituents where only the Meuse can have been involved, as compared with those laid down below the confluence of that stream with the Rhine.

One feature of our authors' results is their corroboration from different data of those obtained by Sir Joseph Hooker regarding the distribution of Arctic plants. Study of large genera widely distributed in the northern hemisphere suggests that during the latest southward flow distinct routes of migration were followed. The flora of the Reuverian horizon which antedated the precedent northward flow shows, as might be expected, an intermixture of elements characteristic of what are now somewhat specialised floras. One instance of this is illustrated by the figures from Plate VI. here reproduced. The figures 9 *a, b* show a fruit which our authors refer to the genus Hakea, the family of which is no longer European, alongside those of an existing Australian species, figured in 10 *a, b*. Another curious point is brought out by these figures. In a noticeable number of these Reuverian plants the carpels or seeds are considerably smaller than in existing species of the same genera. Besides Hakea may be mentioned Alisma, Bucklandia, Epipremnum, Liriodendron, Mimusops, Nelumbium, Trapa, Zelkowa, and the list might be extended.

Those who have had to identify, in the jetsam of a tropical sea-beach, the seeds and fruits of species growing close at hand, can understand better than others the difficulties our authors must have experienced in dealing with material in every stage of decay, due to submersion and dissolution caused by pressure. But even these can only dimly appreciate the labour involved in identifying material yielded by species which no longer exist, with no better help than the all too inadequate carpological collections of even the best European herbaria can afford.

More than a passing acknowledgment is due to the care with which this work in a foreign speech has been printed for the Netherlands Institute for Geological Exploration. There are very few of the slips which seem inevitable under such conditions. "Tot" for "to," "al" for "all," "ot" for "or" do indeed occur, but the only one which calls for correction, in addition to those indicated in the errata at the end of the text, is "exerted" for "exserted" on p. 78.

NATIONAL ECONOMY IN FUEL.

THE need for economy in our national life has been urged upon us in the most emphatic manner by his Majesty's ministers and others, and there can be no doubt but that, great as efforts to economise may have been in recent months, still greater efforts must be made in the immediate future. From the national point of view there can be no greater need than for the most rigorous economy in the utilisation of our coal supplies. The appointment of a committee by the British Association, as announced in NATURE of October 21, shows a timely appreciation of the necessity for, and a desire to do everything within the powers of the association to achieve, economy in this direction.

The question is not a new one. It was considered exhaustively in the report to the Royal Commission on Coal Supplies, 1901–1905, and many eminent men have directed attention to it. Sir William Ramsay dealt with the subject some few years since in his presidential address to the British Association, and advocated the formation of an annual stocktaking commission. More recently, at Cardiff, Prof. H. E. Armstrong emphasised the necessity for more scientific methods, and a committee was formed to deal with points of benefit to local industries, which would necessarily include coal. But hitherto the question has been treated mainly from the point of view of exhaustion of our supplies, and it cannot be claimed to have attained any great success. On the whole, waste in production and most uneconomical utilisation still persist.

As Mr. Lloyd George has said, "in peace and in war King Coal is the paramount lord of industry." The demand for coal has not been lessened by the war; rather do we find it largely increased by reason of the enormous demands for the output of war material. In Sheffield it has been stated that the consumption of gas for power and heating purposes is ten times greater than before the war. In Birmingham the demand was 13·5 per cent. greater in the past six months than in the corresponding period of last year. Similarly, the demand for electric power is affecting numbers of towns. In addition, the large requirements of our Allies must not be overlooked.

In 1913 the coal output was 287,411,869 tons and the number of employees 1,110,884. Owing to the great response of the miners to their country's call, Mr. Asquith estimated the output as reduced by 12 per cent. or 34½ million tons below the normal. Clearly at no time in our history has need for economy in coal been so absolutely essential.

The reduction in output and the difficulties of transport have been brought home forcibly to the individual by the big rise in prices. Hitherto the realisation of the need for economy has been confined to the few, and therefore been largely futile. The more general recognition of this need is the best augury for the success of the committee's efforts, as far more likely to result in Government action.

Whilst the open fireplace, responsible for so much waste, still retains its popularity, consumers may be trusted to exercise greater personal care with coal at its present prices than in the past; but the undoubted extension which will take place in the utilisation of gas for heating and cooking, and of coke in the grate, will ensure far more efficient utilisation of coal. Further, the householder can, at this juncture, be brought to realise how essential to the supply of the munitions of war the by-products of the gas industry are; products he sends to waste up the chimney.

In production every waste must be avoided and the output per head of the mining population largely augmented, although this will at once bring its attendant troubles over hours of labour.

In America the output is higher than in this country, a result ascribed to the more general use of improved cutting machinery and the greater capacity of mine tubs. But naturally economies at the pit will, to a considerable extent, have to wait, the whole energy of the management being concentrated on increased output in face of shortage of skilled labour. In the utilisation of coal for power and industrial heating we have been extravagantly wasteful in the past, but of recent years there has been a marked improvement through the introduction of more efficient power-generating plant. In the case of steam, the higher efficiency of engines, and particularly the introduction of the turbine, has lowered fuel consumption per horse-power. The extended use of power-gas plants has given a very low cost of fuel for both power and heating purposes, and enabled poor-class coal to be employed efficiently and valuable by-products to be recovered. Much improvement may still be effected through further developments in these directions, and particularly in the more scientific control of methods of combustion and gasification by trained fuel specialists.

In connection with the metallurgical uses of coal, it is impossible to compute the amount of waste in the past by the coking of coal in the old type bee-hive oven, in which no inconsiderable proportion of our coke is still produced, and as long as one of these ovens is in use, unnecessary waste is being entailed. There has fortunately been a steady increase in the introduction of by-product recovery ovens, and about two-thirds of the total coal carbonised for metallurgical coke (more than 20 million tons) is treated in recovery plant. When the valuable by-products, which include benzene and toluene—so much in demand for the production of high explosives—and sulphate of ammonia are considered, it is obvious that any coal carbonised in non-recovery plant leads to absolute waste of valuable materials, in addition to a prodigal waste of heat units. Prof. W. A. Bone, in addressing the Chemistry Section at the meeting of the British Association in September, suggested that, in the public interest, the Government might fix by law a reasonable time-limit beyond which no bee-hive coke-oven installation should be allowed to remain in operation.

The present writer, several years ago, in a lecture on fuel economy, urged the necessity of a comprehensive study of our coal supplies in order to afford systematic information as to the suitability of the different seams for various industrial purposes, as being essential to the most efficient use of our supplies, and advocated the establishment of a Government fuel-testing laboratory on the lines of the United States Bureau of Mines laboratory. Prof. Bone, in the address referred to, suggested a memorial to the Government for the establishment of a similar central organisation. It may be that at present difficulties in the provision of funds for this purpose would be great, but there can be no doubt of a very adequate return for the outlay, and if the committee appointed by the British Association can secure a sympathetic consideration of this question, it will have done an incalculable service to the community and have fully justified its existence, independently of the other fields in which its activities will find scope.

J. S. S. BRAME.

AGRICULTURAL EDUCATION AND RESEARCH.[1]

WE open the latest report on Grants for Agricultural Education and Research wondering how the war is going to affect the liberal policy adopted in recent years by the Board of Agriculture. It is satisfactory to find that the Board means to continue on the high plane on which it started: economies there will have to be, but the main lines are, for the present at least, to continue as before.

Perhaps the most important change during the year has been the framing of new regulations for the distribution of grants for agricultural education and research. Hitherto the grants have been paid in several different ways; in future there is to be more uniformity of procedure. When Government aid was first given to agriculture in the form of "whisky money," it was left to the local authorities to decide how they would spend the money. Some simply used it as a dole to the farmer and applied it towards the relief of the rates; others set up local schools; others, again, realising the need for higher work, set up colleges and aimed at having scientific investigations carried out.

This diversity of aim on the part of the local authorities was accompanied by equal diversity of procedure on the part of the Board, and the schemes were aided on four different plans, viz., by block grants made to colleges, by farm institute grants paid on a partnership basis, by grants representing the agricultural shares of block grants previously paid by the Board of Education, and by grants in aid of particular schools and classes based on the number of pupils and hours of attendance. By skilful management, an astute county council clerk could manage to draw the bulk of the money out of the State, basing the claim for gants on expenditure which was really being met by "whisky money." The more progressive counties, on the other hand, were hit rather hard, and substantial expenditure by the ratepayers drew little or no assistance from the State, because it was disqualified for some technical reason quite unconnected with the value of the work itself.

It is gratifying to know that all this is now being taken in hand, and a scheme has been evolved for dealing with the matter. The main trouble is, of course, that the taxpayer has parted with his control over the "whisky money," and the local authorities can do with it what they think fit. The Board's scheme has therefore to be attractive, or the backward counties will have

[1] Annual Report on the distribution of Grants for Agricultural Education and Research in the Year 1914–15.

nothing to do with it. Briefly, the essence of the scheme is to secure an effective partnership between the State and the local authority for furthering agricultural education. Each scheme has to be considered as a whole and estimates planned before it is put into operation; then the cost is to be divided between taxpayer and ratepayer on an approved scale.

The effect of the partnership will be more than financial; it is by no means intended that the State shall be the sleeping and paying partner. The agricultural resources of the country have got to be developed to the fullest extent, and this is no time for allowing any backward county council to block the way.

As might have been expected, the war has had a serious effect on the agricultural colleges and research institutes. The best of their young men volunteered at once for military service. Some of the colleges were practically emptied, and the research institutes lost their most vigorous and enterprising workers, some, alas! never to return. But, to the credit of the Board, the principle that education and research must be kept going has so far been successfully maintained, and although the grants are rightly reduced automatically as members of the staff enlist, there is no evidence from the report that any of the institutes have suffered financially. In return, it is satisfactory that the Board is able to record that the research institutes and colleges have rendered valuable help in dealing with the special problems arising out of the war. It never was more necessary than now that farmers should have the best expert advice available, and it is gratifying to know that all concerned are doing their utmost to help in the emergency. Research institutes subsidised by Government are new things to the ordinary taxpayer, and a great responsibility devolves on them to justify themselves in the present emergency. If science can help agriculture, surely this is the time for doing so.

SIR HENRY ROSCOE, F.R.S.

BY the death of the Rt. Hon. Sir Henry Enfield Roscoe, through heart-failure, on December 18, at his residence, Woodcote Lodge, West Horsley, we lose one more of that rapidly dwindling body of men of whom Huxley may be said to be the type and leader, who spent their energies, after the passing of the Education Act of 1870, and largely in consequence of it, in attempting to rouse this country to a sense of the national importance of secondary and technical education. Except for occasional trouble with gout, and the slight infirmities of advanced age, he was in his usual state of good health and happy serenity of mind up to within the very hour of his seizure. It was such a passing as he would himself have desired; a swift and painless ending to a long, strenuous, and honourable career.

As he tells us in his "Life and Experiences," an autobiographical record which he published in 1906, with the characteristic motto on its title-page, from Carlyle's "Sartor Resartus,"

> What is the use of health,
> Of life, if not to do some
> Work therewith?

he first saw the light at 10 Powis Place, off Great Ormond Street, London, on January 7, 1833. His father, Henry Roscoe, was a barrister, and became Judge of the Court of Passage in Liverpool; his "Digest" was for many years a standard work of reference. Roscoe's grandfather, William Roscoe, was a still more remarkable man, who from very humble beginnings raised himself to a position of affluence, and of considerable influence in his native town. He represented Liverpool for a session in the Parliament of 1806 as an advanced Liberal, but in 1816 lost his fortune by the failure of a bank in which he was a partner. He left his mark on our literature by his "Lives of Lorenzo di Medici and Leo X." He also made occasional contributions on botanical subjects to the Linnean Society.

Roscoe's mother was a Miss Fletcher, the daughter of a Liverpool merchant, who also lost his money by the failure of a bank. She was a highly capable woman, of great force of character, and lived to a green old age. She had considerable artistic gifts, and on the death of her husband after five years of married life, when she was left with very straitened means, she gave lessons in painting. She had, too, literary ability, and when well advanced in years published a life of "Vittoria Colonna," with admirable translations of the sonnets. Roscoe's forbears on both sides were of Presbyterian or Unitarian stock, his great-grandfather on the mother's side being Dr. Enfield, a colleague of Priestley in the Warrington Academy, and the author of the once well-known "Enfield's Speaker."

After a few years at a preparatory school Roscoe was sent to the High School of the Liverpool Institute, where he had little Latin and less Greek, but, what was remarkable in those days, a certain modicum of science. His teacher of chemistry was Balmain, the discoverer of "luminous paint" and of boron nitride, a genial and capable instructor, from whom he seems to have acquired his taste for the science. At all events he now started experimenting on his own account, and began his career as a lecturer by giving demonstrations to his sister, his cousins, and, no doubt, also his aunts, at a charge of one halfpenny each person, to defray the cost of the chemicals—the summit of his ambition at that time being, as he said, to "burn phosphorus in oxygen on a large scale before an admiring audience."

The attitude of the older universities towards Dissenters at this period caused Roscoe to be sent to University College, London, which he entered in 1848 with a view to preparing for a degree of the University of London. Here he came under the influence of Graham, at that time professor of chemistry, and afterwards of Williamson, who succeeded him. He took his degree in 1853, and decided to follow chemistry as a profession.

He had acted for a short time as Williamson's private assistant, and had helped him in the experimental illustration of his lectures. Williamson was then in the heyday of his activity. It was the beginning of a new epoch, which was destined to have a profound influence on the development of chemistry, theoretical and practical—a movement in which Williamson was a pioneer, and Gerhardt, Laurent, Hofmann, and Kekulé were active agents. It is perhaps idle to speculate what would have been the course of Roscoe's career had he remained at University College in association with Williamson. In mental habitudes the men had not much in common. Roscoe at no time had any active sympathy with the philosophical side of chemistry, and chemical speculation had few attractions for him. His mind was essentially practical, and hence the achievements of determinative chemistry were what he chiefly valued. He probably, therefore, did wisely in going to Heidelberg, for he found in Bunsen a type of mind like his own, and a worker with whom he was in complete accord, and their acquaintance soon ripened into a friendship which ended only with Bunsen's death. How completely the two were in sympathy may be seen in Roscoe's admirable memorial lecture on Bunsen which he gave to the Chemical Society, and it is reflected no less clearly in the pages of his autobiography.

Roscoe's life in Heidelberg and his intimate association with Bunsen brought him into close contact with all that was worthiest in German university life, and he contracted firm friendships with many of the most eminent men of that period—the two Roses, Magnus, Kirchhoff, Helmholtz, Kopp, Koenigsberger, Quincke, and others. He always looked back upon this time as one of the happiest memories of his life. He had to the last a very tender regard for what is best in the German character as it was revealed to him in the many friends he learned to know and to love at this period. He viewed with increasing anxiety and regret the growth of the strained relations between the governing powers in Germany and this country, and his last literary efforts were directed, so far as it was possible to him, to mitigate them. "It would be an outrage to civilisation," he wrote, "if two countries so closely allied in blood and intellectual development should ever come to blows." And when the rupture did come it clouded the few remaining months of his life.

Roscoe's first and only professorship was at Owens College, Manchester, to which he was elected in 1857 as successor to the late Sir Edward Frankland. At that time it was the day of small things with the College. As an institution it was looked at somewhat askance by reason of the terms of its founder's intentions in regard to religious tests and instruction. It was inadequately endowed, and poorly housed in a building of which the only claim to distinction was that it was formerly the residence of Richard Cobden. Fortunately it was staffed by an exceptionally able body of young and enthusiastic teachers, limited in number but united in their determination to keep the lamp of learning alight in the squalid and benighted regions of Deansgate. This is not the place, even if space permitted, to dwell upon the progress and development of Owens College, or to show how it grew eventually into the University of Manchester. During the thirty years of his connection with the institution Roscoe took a leading part in stimulating and fostering this development, and before he severed his connection with it as an active teacher he had the gratification of seeing it attain to full university honours. To this success his efforts in erecting a school of chemistry in no small degree contributed. He made its chemical laboratories famous throughout the world, and at one time or another students from nearly every civilised country were to be found working within its walls. This result was due not so much to Roscoe's influence as a leader in chemical inquiry; students were not attracted as in a German university, solely by the fame of the professor's researches; they came, in the first instance, on account of the thoroughness and comprehensiveness of the instruction; they remained because of the stimulating effect of the atmosphere of research into which they were eventually led.

The scheme of instruction which Roscoe introduced was essentially that at Heidelberg, and he followed Bunsen's methods and example. His success as a teacher was largely owing to his energy, his power of organisation and business aptitudes, his judgment of men and capacity for getting the best out of them. He was not what could be termed a brilliant lecturer; he had nothing, for instance, of the fire and enthusiasm of Hofmann; but his language was simple, direct, and to the point, with not the least pretension to rhetorical effect, in all of which, as in other respects, he resembled Bunsen. Like Bunsen, too, he took considerable pains in the experimental illustration of his teaching; in this he was assisted by a skilful and ingenious collaborator, Heywood, well known to Owens College men of a generation or so ago. How affectionately Roscoe was regarded by his students, and how gratefully they recalled their obligations to him, may be seen from the terms of the address, signed by three hundred of them, which they presented to him on the occasion of his jubilee as a doctor of philosophy of the University of Heidelberg. It may be seen, too, in their gift of his portrait by Herkomer to the late Lady Roscoe on his retirement from his professorship, and in the presentation of his bust by Mr. Drury to the Chemical Society on the attainment of his eightieth birthday.

The volume of Roscoe's original work in chemical inquiry when compared with the output of many of his contemporaries, especially on the Continent, cannot be considered large. His most important investigations were his photochemical researches, partly done in concert with Bunsen, and his work on the chemistry of vanadium. His first memoir on the latter subject was made the

Bakerian lecture of 1868, and the value of both was further recognised by the Royal Society by the subsequent award to him of a Royal Medal.

Other important work which has long since taken its due place in the literature of the science is his observations on the constitution of aqueous solutions of acids and his investigation on perchloric acid and its compounds.

Roscoe did a notable service to science by his action in making Bunsen and Kirchhoff's work on spectroscopy generally known in this country, and during the early 'sixties there were few of our larger towns in which he did not demonstrate by means of popular lectures the astonishingly interesting results of the then novel form of chemical analysis. His first lectures on the subject in London were republished in collected form, suitably illustrated, and the book had a considerable success and passed through several editions. He made, in addition, a number of original spectroscopic inquiries, the results of which appear in the publications of the Royal Society.

But the work by which he will continue to be known is the service he rendered to teaching by his many manuals of instruction, some of which were highly popular, ran through many editions, and were translated into a variety of languages. Of these the most important is the large treatise in which he co-operated with his former assistant and friend, Carl Schorlemmer, the first professor of organic chemistry in this country, a man of great erudition, and an able and well-informed chemist. No combination of workers could be more happily selected, for each, in a sense, was complementary to the other. Schorlemmer was the bibliographer, with quite a remarkable knowledge of chemical literature and an extraordinarily retentive and accurate memory, whilst Roscoe's gift of exposition and faculty of clear and simple statement and of systematic arrangement enabled all the accumulated wealth of facts to be set forth in an eminently attractive and readable form.

This appreciation is concerned more particularly with Roscoe as a teacher engaged in the pursuit of experimental inquiry, with which aspects of his career the writer may claim to have some right to speak from personal knowledge. It must be left to others to deal with his many other activities during the later years of his life, such as his political life, his work in regard to technical education, and in connection with the still unsolved problem of the true function of a great metropolitan university, and the important services he rendered to preventive medicine in his association with the Lister Institute. T. E. THORPE.

NOTES.

SIR ARCHIBALD GEIKIE, O.M., K.C.B., F.R.S., will reach his eightieth birthday next Tuesday, December 28. He is in excellent health, and still busy with his pen.

WE announce with much regret the death on December 17, at seventy-five years of age, of Sir John Rhys, principal of Jesus College, Oxford, and professor of Celtic in the University. In addition to his other titles to distinction, Sir John Rhys was well known for his work in archæology and anthropology. He was president of the Anthropological Section of the British Association in 1900.

LORD ALVERSTONE, late Lord Chief Justice of England, whose death occurred on December 15, was a fellow of the Royal Society, having been elected in 1902 under a statutory provision, formerly in operation, which allowed of the election of Privy Councillors. He was a familiar figure at the society's annual soirées, and from time to time attended and spoke at the presidential anniversary banquets. Lord Alverstone had a long and traditional connection with the Royal Society of Arts, the son in this respect continuing the highly useful services rendered by his father, Mr. Thomas Webster, Q.C. Elected on the council in 1883, he was chairman of that body from 1890 to 1894, remaining afterwards an ordinary member of council for a long period of years. On King George's accession to the throne in 1910, the presidency of the society became, thereby, vacant, and the late Lord Chief Justice accepted the post. He resigned in 1911 in order to make way for his Royal Highness the Duke of Connaught. It may be recalled that Lord Alverstone opened the proceedings of the "Law, Political Economy, and Legislation Affecting Chemical Industry" Section of the International Congress of Applied Chemistry, held at South Kensington in 1909, giving a thoughtful address on the right method of legislating upon and dealing with scientific technical knowledge.

THE letters in the *Times* during the last few days from Mr. C. H. L. Alder, Sir William Ramsay, and Mr. J. A. Goudge again direct attention to a remarkable state of affairs. As recently pointed out in NATURE, Germany is necessarily suffering from a serious shortage of fats, and consequently of glycerine, which is obtainable from no other source. Notwithstanding our supposed blockade, Germany is making up for this shortage by the import, through neutral countries, of fats and oil-containing seeds. Though primarily produced abroad, the fatty materials to a large extent pass through British hands and British ports. In the correspondence referred to, disturbing statistics are given concerning linseed, which is one fatty material out of many. Sir William Ramsay shows by a simple calculation that from linseed oil alone our Government has furnished the enemy with no fewer than 18,000 tons of gun ammunition. Actually the position is much worse, and the additional complication is now arising that, owing in part to the general dislocation of transport, there is more than a possibility of a future shortage of fatty materials, and consequently of glycerine, in this country. The price of fats here is rising in an alarming manner, though since their cost is still small compared with that ruling in Germany, the financial temptations to export to neutral countries bordering on Germany remain immense. It is difficult to understand whether the present policy of the Government is due to want of knowledge or to reasons of high

politics; if the former, we may justly ask what are the Government chemists and the scientific Advisory Committees doing to enlighten responsible authorities on this matter?

THE death is announced of two ex-directors-general of Indian Telegraphs. Mr. J. Horsburgh Lane, who was deputy-director-general in 1890, and officiating director-general in 1892, retired in 1894. He was the compiler of a "Word Code for Foreign Telegrams," and at the time of his death had reached the age of seventy-six years. The other Indian Telegraph Department official who has just died was Mr. F. Gurr Maclean, who was director-general from 1900 to 1903, when he retired. He died at Woking, aged sixty-seven years.

THE Government has decided that all medical students, except those in the two last years of professional study, are to relinquish their work and become combatant members of the Army. While it must be recognised that the interests of the community must be subservient to the military needs of the State, the heavy drains now being made on the medical reserves of the nation may well in the future bring about an acute shortage of medical men. As the *Morning Post* pertinently asks: What is going to happen if the war is prolonged, and few new medical men become available in the future? For under the present policy, after the end of 1916, no present students will become qualified except a few medically unfit for the Army. Altogether probably not more than 600 or 700 men are involved—a negligible contribution to the fighting forces of the Army—but a number which in four or five years' time would be of the greatest value in augmenting the then depleted medical service of the country. We are already suffering from a diminished birth-rate, an increasing death-rate, and an increased infant death-rate, and if the medical care of the community be lessened, as it inevitably will be if there are no fresh doctors, these evils will certainly increase. If these students could be made use of as dressers and attendants, and the time so occupied were allowed to count towards the time required for the medical curriculum, the difficulty would be partly met. The first and second year students should at least be relegated to so late a class in the reserved groups that their calling up will occur only in the case of the most desperate need.

DR. ORVILLE A. DERBY, whose death at Rio de Janeiro we reported last week, was one of the most active pioneers in the geology of Brazil, and did great service to science by the influence he was able to exert on the Brazilian Government. A pupil of Prof. C. F. Hartt, of Cornell University, whose well-known "Geology and Physical Geography of Brazil" was published in 1870, he followed in his teacher's footsteps, and in 1879 was appointed director of the Geographical and Geological Commission of the State of San Paulo. In 1906 he removed to Rio de Janeiro as director of the newly instituted Geological and Mineralogical Service of Brazil, and there remained full of activity until his last brief illness. Dr. Derby's first original paper was a notice of some Palæozoic fossils collected by A. Agassiz and S. W. Garman near Lake Titicaca, in 1876; and in the two following years he published in the Archives of the National Museum of Rio de Janeiro important memoirs on the geology of the Lower Amazons and the neighbourhood of Bahia. In 1878 he also described the diamond-bearing region of Paraná, and in later years most of his researches were concerned with petrology and the distribution of the sources of the rarer minerals. To the end, however, he was interested in the purely scientific aspect of his work, and one of his last papers was on the microscopical structure of the Permo-Carboniferous fern-stem, *Psaronius brasiliensis*. He was ever ready to welcome and help other geologists who visited the country for special purposes, and in 1906 he co-operated with Prof. J. C. Branner, of Leland Stanford University, in producing a useful manual of elementary geology adapted for Brazilian students. Dr. Derby became a fellow of the Geological Society of London in 1884, and was awarded the Wollaston Donation Fund in 1892.

THE juvenile lectures of the Royal Society of Arts will be delivered by Prof. J. M. Thomson and Mr. J. Swinburne. Prof. Thomson will give the first lecture on January 5, his subject being "Crystallisation," and Mr. James Swinburne will give the second on January 12, upon "Science of Some Toys." Both lectures will be fully illustrated with experiments.

WE have received from Mr. F. W. FitzSimons, of the Port Elizabeth Museum, an abstract of his paper on the fossil human skull from Boskop (Transvaal), read before the meeting of the South African Association at Pretoria. It is essentially identical with his letter on the subject published in NATURE of August 15, 1915 (vol. xcv., p. 615), and indicates clearly that, although he emphasised the high state of mineralisation of the fossil, he had no intention of referring it to so remote a period as that of the Karoo reptiles.

THE President of the Board of Agriculture and Fisheries has appointed a Committee for the purpose of making such arrangements as are likely to ensure the fullest use being made of native resources in supplying existing demands for timber. The Committee is prepared to purchase standing timber and to make arrangements where necessary for felling, hauling, and conversion. All communications for the Committee should be addressed to the Secretary, Home Grown Timber Committee, Craven House, Northumberland Avenue, W.C.

ON Sunday evening, December 19, a great fall of chalk took place on the cliffs which overlook the picturesque Warren, near Folkestone, and it is reported that a considerable amount of damage has resulted. The South-Eastern Railway line, which runs along the foot of the cliffs, has been buried for a considerable distance under the débris, whilst the main road between Folkestone and Dover near the edge of the cliff exhibits long cracks about 4 in. wide, and heavy traffic has been stopped. Fortunately, no lives were lost, and although a house built only a few years ago on the face of the cliff was involved in the fall, the

occupants luckily escaped. The fall is undoubtedly due to the recent spell of wet weather, and the explanation is simple. At this point the chalk dips inland at a low angle, but the various joint-planes which traverse the bedding at right angles emerge in the face of the cliff. The enlargement of these joints by the percolation of water weakens the overlying mass of chalk, which finally slips forward, and its detachment gives rise to the fan-shaped scar so characteristic of the cliffs in east Kent.

ON and after January 1, 1916, the following fees will be charged, in the interests of national economy, for admission to the Royal Botanic Gardens, Kew:—On Mondays, Wednesdays, Thursdays, Saturdays, Sundays, and Good Friday, 1*d.*; on Tuesdays and Fridays, except Good Friday (students' days), 6*d.*; a charge of 3*d.* is made for the admission of photographic apparatus. Bath-chairs will be permitted to enter the gardens during public hours when the condition of the paths is suitable on payment of 1*s.* on students' days (Tuesdays and Fridays, except Good Friday), and on payment of 6*d.* on other days. Students' permits, available until the close of the calendar year, and obtainable on written application to the director by *bonâ-fide* students and artists, will be issued on payment of a fee of 5*s.* These permits will cover free entrance on students' days and before public hours on week days, except Good Friday and Bank Holidays. Season tickets, available until the close of the calendar year, can be obtained on written application to the director on payment of a fee of 1*l.* These tickets will cover admission on any day during public hours.

WE learn from *Science* that, at the request of President Wilson, the National Academy of Sciences has appointed the following to investigate and report on the control of the Panama land-slides:—President C. R. Van Hise, University of Wisconsin (chairman); General H. L. Abbott, Cambridge, Mass.; Dr. G. F. Becker, United States Geological Survey; Prof. J. C. Branner, Stanford University; Dr. Whitman Cross, United States Geological Survey; Dr. A. L. Day, Carnegie Institution; Dr. J. L. Hayford, Northwestern University; Prof. H. F. Reid, Johns Hopkins University; Dr R. S. Woodward, Carnegie Institution; C. Carpenter, Ithaca, N.Y.; A. P. Davis, United States Reclamation Service; J. R. Freeman, Providence, R.I.

WE notice that Dr. J. N. Rose, of the United States National Museum, and his assistant, Mr. Paul G. Russell, have recently returned from an extensive journey in Brazil and Argentina, where they have been engaged especially in making a collection of Cactaceæ from the South American desert regions. The expedition was undertaken in connection with the exhaustive study of the Cactaceæ of North and South America, which Dr. Rose is making for the Carnegie Institution of Washington. In addition to the extensive collection of herbarium material which has been brought to the National Museum, large collections of plants in a living condition were brought back and are now on exhibition in the New York Botanical Garden. The publication of Dr. Rose's results of his journey will be eagerly awaited, and cannot fail to be of as great interest and value as his former contributions to the desert botany of the United States.

A GENEROUS tribute to the memory of the late Prof. Meldola was paid, we learn from a report in the *Times*, by Lord Reading, the Lord Chief Justice, at a meeting of the Maccabean Society on December 14. Lord Reading said:—Humanity and science were both mourners and sufferers by the death of Prof. Meldola. No one whose life was not spent in science could have any conception of the varied aspects in which Prof. Meldola touched life and adorned it, and of the wide outlook which he had over the world. He was in every respect a most lovable man. Since the war, he had done much work for the Government, by whom it was highly valued. There must come eventually a period of reconstruction in the country, and when that time came we should miss the work which Prof. Meldola could have done. He had left a lasting memorial of himself in all his life, not least in the last part of his life.

FOREMOST in the equipment of the protagonist of airships is a plentiful supply of optimism; possibilities must perforce loom much larger than actual achievement when the latter is meagre. In an article entitled "Possibilities of the Large Airship," contributed to the *Fortnightly Review* for December, Mr. A. J. Liversedge does not trouble much over the technical difficulties of large airships, being concerned chiefly to prove that they are "worth while." In fact, he regards the construction of large semi-rigid dirigibles as being well within the capacity of borough engineers or surveyors, assisted by "woodworkers, handymen, and youths and female labour." "Plans, the necessary direction, and the finance would, of course, be provided by a central authority. . . ." Mr. Lloyd George would provide the engines through the Ministry of Munitions. We may believe in large airships and their usefulness both in war and peace, without visualising them coming quite in that fashion. It smacks too much of an article in one of the domestic periodicals describing how, with the aid of "a friendly carpenter," a packing-case becomes a sideboard or a wardrobe. Mr. Liversedge's optimism seems of the wrong sort, and his visions of the functions of airships in war somewhat awry, ignoring as they do in many cases the possibilities of easy destruction, by the enemy, of the airship. But to one who is so optimistic about their production, the loss of one or two would not perhaps matter.

THE collection of gem-stones formed by the late Sir Arthur H. Church has, in accordance with a wish expressed in his will, been presented by his widow to the trustees of the British Museum, and is now on exhibition in the recent addition case in the Mineral Gallery of the Natural History Museum at South Kensington. It comprises about two hundred selected and choice faceted stones, most of them mounted in gold rings, and the whole is of considerable intrinsic value. The stones are referable to twenty-one mineral species, so that, with the notable exception of diamonds, most of the species that have been used in jewelry are represented. The interest of the collection, however, lies more in the strong suites afforded by certain species, illustrating well the wide ranges of colour which may be exhibited by one and the same kind of

stone. This is particularly the case with zircon, a mineral to which Sir Arthur Church had devoted much study, though unfortunately he had not completed his observations or prepared them for publication. Of this species there are sixty-nine faceted stones, ranging from colourless to various shades of red, brown, yellow, green, and even sky-blue. Other strong suites are of tourmaline, garnet (including a fine example of spessartite, the rare manganese-garnet), spinel, opal, corundum, chrysoberyl, and peridot. Examples of rarer species represented in the collection are phenakite, andalusite, and enstatite.

BY means of a submerged chamber, provided with large glazed apertures and entered through a tube attached to the well of a specially constructed barge, the brothers G. and E. Williamson have devised a means whereby they can take kinematograph pictures of marine animals and make surveys of the ocean floor, down to a depth of as much as 30 fathoms. The complete success of their ingenious method was demonstrated at a private view, given on Tuesday afternoon, at the Philharmonic Hall, London, and the exhibition will be open to the public in a few days. Some remarkable pictures, taken in the Bahamas, were thrown on the screen, showing "snappers" and other fish which haunt coral reefs, divers gathering sponges, sharks attracted by a dead horse suspended in front of the observation chamber, and, finally, an encounter with a shark by one of the inventors of the apparatus. Pictures taken at night, by means of several Cooper-Hewitt mercury vapour lamps, were also shown. The inventors claim that their apparatus will enable treasure to be raised from vessels sunk in shallow water with far more ease than hitherto, since they have devised a means of pushing the arms through special apertures, enabling the diver to seize objects seen through the observation chamber. Another and very real advantage of this method of submarine work is that the operator is enabled to remain at work for long periods without suffering the discomforts inseparable from the ordinary means of diving. From a spectacular point of view it is to be hoped that the inventors will be able further to improve on their chamber, for it is distinctly distracting to see the floor of the ocean heaving to slow music while fishes of various bizarre shapes and colours disport themselves for our edification. This movement is at present inseparable from the rise and fall of the barge with the swell. If the chamber could rest on the bottom, by lengthening the tube, this motion would be avoided.

THE director of the Meteorological Office informs us that during the last three months a number of auroras have been reported by Mr. G. A. Clarke, the observer at King's College, Aberdeen. His latest report on the subject refers to a fine display commencing about 6 p.m. on December 6, and lasting until after midnight. It seemed to attain its maximum between 8 p.m. and 10 p.m. About 9.30 p.m., according to Mr. Clarke's report, a very extensive and bright glow, topped by a narrow arch, stretched from N.E. right round to W. Above this arch at an elevation of 60° from the horizon were some streamers, and a series of very fine rapid pulsations of light of a pale green white to lavender or pale rose tint. The arch and glow were pale greenish, and gave sufficient light to form faint shadows of buildings, similar to what occurs in faint moonlight. This aurora was accompanied, as has been the case with most of the auroras reported recently by Mr. Clarke, by a good deal of magnetic disturbance. At Kew the curves were considerably disturbed during the whole afternoon of December 6, and up to 4 or 5 a.m. on December 7. The total range of declination was about 49′, and that of horizontal force about 170γ ($1\gamma = 1 \times 10^{-5}$ C.G.S.). The most outstanding declination movement at Kew took place between 9.55 and 11.40 p.m.; during this time the needle swung 28′ to the east, and returned practically to its original position. The most notable horizontal force change was a rise of 150γ between 10.20 and 10.45 p.m. These changes, it will be noticed, occurred somewhat later than the hour when the aurora at Aberdeen was most brilliant.

A USEFUL popular account of fleas by Mr. F. C. Bishopp has been issued by the United States Department of Agriculture (Bulletin 248). The life-history of these familiar insect parasites is sketched, and their importance as carriers of bubonic plague and other diseases is duly emphasised. Practical measures for exterminating fleas and gaining protection from their attacks in infested localities are not forgotten; for example, a man sitting in a room inhabited by the insects is advised to wrap his legs with flypaper, or to wear khaki trousers and have them "tucked into high-top shoes."

A KNOWLEDGE of the life-histories of the ecto-parasites of man is, at the present moment, of vital importance to us all, and especially to those of our countrymen who are on active military service. We are glad, therefore, to see in the Journal of the Royal Society of Arts the report of a lecture on this theme by Dr. A. E. Shipley, the master of Christ's College, Cambridge. Herein Dr. Shipley, in his own inimitable way, gives a brief account of the habits and habitats of the head and body louse, the flea, and the bed-bug, and the diseases spread by them. By way of illustrating the devious ways in which these pests extend their range, he remarks of Cimex, the bed-bug, that it was unknown to the aboriginal Indians of North America, and probably, therefore, "entered that continent with the 'best families' in the *Mayflower*"! Other disease-bearing insects, like mosquitoes, tsetse- and other biting-flies, house-flies, and bluebottles and other insects which spoil the food of man, like flour-moths and biscuit "weevils," are each in turn passed in review, and their ravages explained.

IN the *Scottish Naturalist* for December Mr. A. Landsborough Thomson continues his notes on the Aberdeen University bird-marking scheme. We would suggest that where birds are recovered which were ringed as nestlings at the same time and place it would be helpful if it was stated whether they were nest-fellows. A case in point occurs in Mr. Thomson's notes. Two sheldrakes were ringed as nestlings at Beaulieu, Hampshire, in July, 1912; one was recovered

at Saltash, Cornwall, in February, 1913, the other at Busum, in Schleswig-Holstein in August, 1913.

THAT closely similar and nearly related species may sometimes be more easily distinguishable by their behaviour than by their physical characteristics is shown by Mr. Walter Ritchie in the *Scottish Naturalist* for December, wherein he describes "The Smaller Pine Beetle (*Myelophilus minor*) in Aberdeenshire." *M. minor* and *M. piniperda* are two small bark-beetles, which are to be distinguished one from another only after very careful scrutiny. Yet the tunnels which they drive beneath the bark of trees are strikingly different in character, so that there can be no possible confusion in the plan of the mother and brood-galleries of the two species. The mother-gallery of *M. piniperda* forms a vertical shaft from which the very long larval galleries are given off on either side at right angles. In *M. minor* the mother-gallery is biradiate, and runs transversely to the long axis of the tree-trunk, while the larval-galleries are very short, and running at right angles to the mother-gallery. They thus come in consequence to run in the same direction as the mother-gallery of *M. piniperda.*

PARTS 10 (Series A and B) of the third volume of the *Review of Applied Entomology* have just been issued by our Imperial Bureau. Of special interest among the summaries of foreign literature are accounts of Prof. N. A. Cholodkovsky's latest work on the Chermesidæ (Dept. Agri., Petrograd, 1915), and if Dr. O. N. Paleitchuk's detailed instructions for the treatment of bees infected with *Nosema apis*. Unfortunately we are not told if the prescription, when adopted, proved effectual.

THE Consular Report (Annual Series, No. 5496, 1915) on San Thomé and Principe indicates the remarkable success achieved by the Portuguese authorities in their drastic measures taken to exterminate the tsetse-fly and sleeping sickness on these islands. The death-rate has fallen steadily, and in 1914 only 52 people died of the disease at Principe; only eight persons on the island were still suffering from it, and they were all old cases. The conquest of the epidemic has no doubt been due to the campaign against the tsetse-fly. None have been caught since April 11, 1914, although the reward has been raised from one to five dollars per fly. Thirty-four flies were caught in 1914. The report remarks:—"Apparently there is every reason to believe the fly has now been completely exterminated in the island."

THE Records of the Indian Museum, vol. xi., part 4, contains some valuable notes on Indian parasites of fish by Mr. T. Southwell. He is of opinion that some species at least of the larval Trematodes which live in the skin and flesh of fishes may mature in the human intestine. The ectoparasitic crustacean, *Argulus foliaceus,* he found to be a serious menace in confined tanks. This was demonstrated in the case of a number of Indian carp (*Labeo rohita*), which, about a month after being placed in the tank, became sluggish and floated on the top of the water. When removed they were found covered with Argulus. All the fish were then captured, scraped clean, and returned to the water. An upright bamboo was then placed in the centre of the tank, and this was immediately used by the fish as a mean of rubbing off their unwelcome adherents. No more deaths occurred after this date. It is unlikely that frogs assisted in keeping down this parasite, though the author inclines to this view.

ACCORDING to the theory of parallel axes, any quadratic function of the co-ordinates and their rates of change of a system of masses may be represented as the sum of two terms, one being the same as if the whole mass were concentrated at the centre of mass, and the other representing the corresponding function of the relative co-ordinates and their rates of change referred to the centre of mass as moving origin. Unfortunately, however, there has been a tendency in certain quarters to reproduce misstatements in which similar properties are alleged to hold good with regard to points other than the centre of gravity. Prof. E. Bidwell Wilson communicates to the American *Mathematical Monthly,* vol. xxii., No. 6, a note on "Linear Momentum, Angular Momentum, and Kinetic Energy," in which it is sought to enunciate the precise forms which these dynamical magnitudes assume when expressed in terms of the motion of an arbitrary point and of the relative motion of the system with respect to that point. It is desirable that these results should be studied in detail by teachers of mechanics, but it will be evident from a perusal of the paper that the student should be warned invariably to choose the centre of mass as the moving point with respect to which the dynamical magnitudes under consideration are expressed as the sum of two terms. We have seen it stated that in forming equations of motion it is only possible to take moments about either a fixed point, the centre of gravity, or the instantaneous centre in the case of small oscillations. As a matter of fact, moments may be taken about any point whatever provided that the mass accelerations of the system are properly specified in the form of a force through the centre of gravity and a couple.

THE Journal of the Washington Academy of Sciences for November 19 contains an abstract of a paper on the mechanical properties of zinc-bronze by Mr. H. S. Rawdon, of the Bureau of Standards, which will ultimately appear in full in the Bulletin of the Bureau. The alloy has the composition, copper 88, tin 10, and zinc 2 per cent., and considerable variation in the method of preparation may be made without the structure being seriously affected. In the cast condition it consists of a matrix of relatively large crystals of a solid solution of tin and possibly zinc in copper, in which are embedded numerous particles of a hard, brittle eutectoid. When broken in tension the fracture occurs along the cleavage planes of these crystals, and their size and relative positions in the cross section of a test bar have a considerable effect on its strength. The most serious cause of fracture is, however, the

presence of oxides in the form of pits and films, and in almost all cases in which a test bar failed under a load less than 35,000 lb. per sq. in., the failure was traced to these oxides of tin and zinc.

AT the end of last year the important plumbago mining industry in Ceylon was suffering very severely from the loss of the German and Belgian markets and from other causes connected with the war, and steps were taken by the Imperial Institute to induce users of plumbago in the United Kingdom to buy the whole of their supplies from Ceylon instead of partly from Ceylon and partly from foreign countries as previously. Recent statistics indicate that progress has already been made in this direction, for it is significant that the percentage of Ceylon plumbago exported to the United Kingdom during the first ten months of the present year is considerably greater than in 1913. Moreover, the total exports to this country from January to October this year are more than double those of the corresponding months in 1914, and, in addition, Russia is a large new purchaser. The most important use of plumbago is in the manufacture of steel works crucibles, which are required to resist the effects of great variations of temperature; and it is gratifying to know that a source within the British Empire is available to supply the demands of our munitions works for these articles.

THE Cambridge University Press will publish very shortly a supplementary volume of Scientific Papers by Sir George Darwin. It will be edited by F. J. M. Stratton and J. Jackson, and contain lectures on Hill's lunar theory, a paper on periodic orbits, the inaugural lecture delivered in 1883 on the author's election to the Plumian professorship at Cambridge, and an address to the International Congress of Mathematicians in 1912. In addition, the volume will include memoirs of Sir George Darwin by, respectively, Sir Francis Darwin, on his life apart from his scientific work, and Prof. E. W. Brown on Darwin as astronomer, mathematician, and teacher.

OUR ASTRONOMICAL COLUMN.

o CETI.—The maximum of this star is not "due" until January 8, 1916, but strict regularity is not a feature of its light curve, and it has already reached 3·0 magnitude (December 16), being only slightly less than α Ceti (2·7 mag.), and is thus a full magnitude brighter than at the last maximum. The present apparition strongly recalls that of December, 1906.

COMET 1915*e* (TAYLOR).—Since this comet was observed at Washington many observers have managed to find it. An observation made with the 10-in. refractor at the Hill Observatory on Thursday, December 16, 13h., gave the following approximate position, R.A. 5h. 16·7m., declination $+2^\circ\ 13'$, whence it appears that the daily movement is accelerating. As the comet is evidently approaching, increasing in brightness and very favourably placed for observation, it may be expected to become a fairly conspicuous object.

From observations made on December 6 at Washington, and on December 9 and 12 at Copenhagen, Messrs. Braae and Fischer-Petersen have calculated the following orbit and ephemeris:—

$$T = 1916 \text{ Feb. } 26{\cdot}426 \text{ t.m.B.}$$

$$\left.\begin{aligned}\omega &= 18^\circ\ 27'\ 38''\\ \Omega &= 107^\circ\ 6'\ 55''\\ \iota &= 21^\circ\ 52'\ 59''\end{aligned}\right\}1915{\cdot}0$$

$$\log q = 0{\cdot}19358$$

		R.A. h. m. s.		
Dec. 25	...	5 11 1	...	$\delta + 5^\circ\ 7'{\cdot}6$
29	...	8 34	...	6 40·3
Jan. 2	...	6 22	...	8 21·8

The comet's distance from the sun diminishes from 172 to 160 million miles between December 13 and January 2, and it comes about ten million miles nearer the earth in the same time. On December 12 it is stated to have been of about the eleventh magnitude.

GEMINID METEOR SHOWER.—Mr. Denning sends the following notes of observations of this shower:—Mrs. Fiammetta Wilson, observing from Wokingham, on December 11, 6h. 30m., to midnight, saw thirty-seven meteors, of which nearly one-half were Geminids, from a radiant at $109^\circ+32^\circ$. On December 11 thirty-two meteors were seen before midnight, and a very distinct radiant was found at $117^\circ+31^\circ$.

Miss A. G. Cook observed the shower from Stowmarket on December 11 until interrupted by clouds at 10.30. The radiant was at $109^\circ+33^\circ$.

Mr. T. Hargreaves, at Eton, watched for meteors on the evenings of December 11, 12, and 13, and morning of 14, and recorded forty, of which about eight, seen from 12h. 28m. to 13h. 16m. on December 13, were Geminids with a radiant at $111^\circ+30^\circ$.

Mr. Denning, at Bristol, looked out on December 12, 15h. 30m. to 18h., and in about $1\frac{3}{4}$ hours of that interval saw twenty-five meteors, 18 per cent. of which were from a double radiant at $110^\circ+33^\circ$ and $118^\circ+32^\circ$. Clouds prevented observation on December 13 and 14, but on December 15, 15h. 40m. to 16h. 10m., thirteen meteors were counted. Not a single Geminid was seen; the shower appeared to be over.

On December 15, 8h. 23m., a fireball was seen from Bristol falling low in due north, path about $207^\circ+53^\circ$ to $210^\circ+47^\circ$. It must have been a splendid object from the north of England and south of Scotland.

Judging from the results of the foregoing and some other observations, it seems certain that the display was not above the normal character. Moonlight, however, partially interfered, and several cloudy nights at the most important period prevented efforts to corroborate the easterly motion of the radiant.

NOTES ON VARIABLE STARS.—A sudden maximum of UV Persei was observed by E. Hartwig (*Astronomische Nachrichten*, 4815) on September 2, the star reaching 11 mag., although less than 13–14 mag. on August 28. On September 4 it was again invisible. This fleeting illumination was also observed by Prof. A. A. Nijland (*Astronomische Nachrichten*, 4818), who reports that the star could not be found on August 31. On September 3 it was as bright as the comparison star, but the following night had vanished. The previous maximum occurred on June 19, 1914—*i.e.* 434 days earlier.

Some interest attaches to a new variable star, 4, 1915 Orionis (1900, 4h. 58m. 46s., $-4^\circ\ 20{\cdot}8'$), discovered by Mr. J. Voûte, who, seizing a fortuitous opportunity, observed it passing through an extraordinary fluctuation of light last September (*Astronomische Nachrichten*, 4821). Estimated magnitudes were:—

1915	Sept. 12	8·5 mag.	Sept. 28	7·12 mag.
	Sept. 23	6·4 mag.	Oct. 4	8·3 mag.

The variability of RU Cassiopeiæ and the neighbouring star, P.D. 695, was not supported by photographic measures recently published by Dr.

Münch. The visual observations made by von Guthnick during the summer of 1911 (*Astronomische Nachrichten*, 4818) show that the average amplitude of the light curve is 0·25 mag. in each case, and the periods are just about one day. With magnitudes about 5·8 and spectra of the usual advanced helium type (B8–B9) either would supply the Ottawa observers with just the stiff kind of spectroscopic problem they seem to revel in.

The light curve of a new Algol star, 3, 1915 Coronæ (BD+30°, 2688, 9·1 mag.) has been published by von Cuno Hoffmeister (*Astronomische Nachrichten*, 4821) who first detected its variability during August, 1914. A series of observations, including fifteen minima, gives the following elements:—Period, 17h. 26m. 4·18s.; normal magnitude, 9·28; minima, 9·76; duration of phase, 4·3 hours.

A TUNGSTEN ARC LAMP.

A NEW and extremely interesting development of the nitrogen- or argon-filled electric lamp is described in a paper by Messrs. E. A. Gimingham and S. R. Mullard in the Journal of the Institution of Electrical Engineers for December 1. The lamp is the result of experiments started in 1913 in the Edison and Swan United Electric Light Co.'s laboratory. Instead of the light being emitted by an incandescent spiralised filament of tungsten, it is given out by an actual arc between tungsten electrodes.

The first problem to be solved was, of course, to strike the arc. In the first forms of lamp, two tungsten electrodes were normally in contact, and an expansion strip consisting of a strip of molybdenum, to one side of which was welded a thin strip of copper, was fixed to one of the electrodes. This strip was heated by a spiral filament of tungsten, in series with the electrodes. It was found, however, that the electrodes were frequently partially fused together, so that the expansion strip failed to separate them, in addition to which a certain amount of spluttering occurred, which shortened the life of the lamp. To overcome this defect, an entirely different method was employed, enabling the arc to be struck between fixed electrodes consisting of two small globules of tungsten. A tungsten filament was made to glow close to the electrodes, and ionised the gas between them. This made the gas conducting. The ionising filament was connected in parallel with the arc circuit, and was connected up for a few seconds only by means of a switch, and then disconnected as soon as the arc was properly struck.

In continuous-current lamps, however, difficulty was experienced in inducing the arc to leave the filament and pass to the negative electrode. The heat of the arc, moreover, destroyed the ionising properties of the filament. To cure this, two expedients were adopted. First of all, instead of a simple tungsten filament, it was found that better ionising properties could be obtained from a mixture of tungsten with zirconia, yttria, thoria, and other refractory oxides, and that, in addition, such a filament had a longer life. Secondly, the use of the expansion strip was reverted to for the purpose of moving the positive electrode along, after the arc had been struck, to another part of the filament, which acts as the negative electrode, and saves the central part of the latter (opposite to which the positive electrode returns when the lamp is switched off) from being rendered inactive.

Such a lamp is shown diagrammatically in Fig. 1. The current first passes through the circuit A and the filament BB′, while at the same time there is the full potential difference of the mains between the tungsten globule, E, and the filament. The gas in this gap is ionised, and the arc strikes. As the main current then passes through the relay C, this is actuated, and breaks the ioniser circuit. Meantime the heat from the arc causes the expansion strip F to warp, and moves E further along the filament.

Alternate methods, used for lamps of higher candle-power, are to arrange the ionising filament and the electrode, so that, after striking, the arc rises away from the active part of the filament, or to employ two electrodes and a change-over switch. In the latter case, the arc is first struck between the filament (connected to the negative pole) and the smaller electrode as anode, and as soon as the latter becomes brightly incandescent, the filament is switched off and the polarity changed, so that the arc is formed between a larger positive electrode and the smaller one, which is now negative.

The efficiency of the lamp, for a life of a few hundred hours, is in the order of ½ watt per c.p., and the intrinsic brilliancy of the light source about 10,000 c.p. per sq. in. Spectrum analysis shows perfect continuity and strength over the whole visible spectrum, and at the same time richness in the ultra-violet.

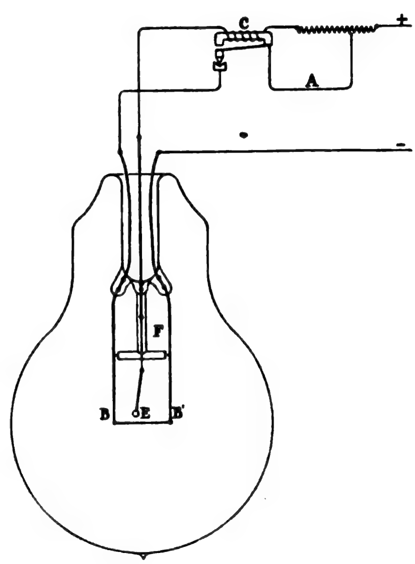


FIG. 1.

One of the immediate applications of the new lamp is for projection purposes, and the manufacturers have already placed on the market a practical form of lantern lamp, with a resistance arranged so that it may be set for any voltage. This lamp is simply started by means of a push switch, which closes the ioniser circuit, and is to be released as soon as the arc is struck. In its smaller sizes the lamp will doubtless displace entirely the Nernst filament which, in spite of its disadvantages owing to the negative temperature coefficient rendering it very sensitive to pressure variations, has been used very largely for small projectors, surgical examination lamps, etc., and has remained popular until the stock of the German Nernst burners in this country at the outbreak of the war became exhausted. For photographic enlargement lamps it should also have a useful field, and, ultimately, as a substitute for arc lamps for kinema theatres, and the internal lighting of shops and large buildings. The spectrum shows that it should be invaluable for colour matching.

THE WORKING AND MAINTENANCE OF STEAM BOILERS.

IN these days of high-priced coal, the memorandum which has recently been issued by Mr. C. E. Stromeyer, chief engineer of the Manchester Steam Users' Association, will be read with much interest by engineers and boiler owners. The coal bill for a Lancashire boiler amounts to from 300*l.* to 600*l.* per annum, and careless stoking may easily increase this cost in a very large proportion. Lack of proper attention to minor defects, which should be remedied as soon as detected, may also greatly increase the coal bill and shorten the life of the boiler. The memorandum covers a very wide field, such as economiser defects, external and internal corrosion, leakage, etc. Of special interest are Mr. Stromeyer's remarks regarding mechanical stokers.

Experience indicates that mechanical stokers, which naturally aim at improved efficiency and therefore high furnace temperatures, require not only that they should be carefully looked after and kept in good repair, but also that the boiler should receive far more care and attention than are necessary with hand-firing. Scale, and to a certain extent grease, may be tolerated in hand-fired boilers, but every effort should be made to remove these injurious substances if increased economy is aimed at by the adoption of mechanical stokers. Mr. Stromeyer gives some illustrations of the increased liability to damage due to increase in the temperature of the furnace. The boilers of a large steamer had been giving no trouble until an improved fire-grate was fitted. A saving of about 10 per cent. in the coal bill resulted, but during the next voyage all the eighteen furnaces gradually bulged, in spite of a reduction of speed and power. The bulging could have been stopped if the improvement due to the new grate had been nullified either by keeping the furnace doors open and admitting an excess of cold air, or by closing all airholes in the doors, restricting the air admission but spoiling the efficiency.

Mechanical stokers designed to burn anthracite will almost certainly fail if fed with coking coal, and *vice versa*. It is not possible to design a mechanical stoker which shall be satisfactory with all classes of coal.

From an economical point of view it is more important to keep the boiler heating surfaces free from soot and tarry matter than to remove the scale from the interior surfaces; the wear and tear question, however, demands that the inside of a boiler should be kept clean. Scale and grease hinder the heat which enters the plate from passing into the water. The radiating power of incandescent fuels, or flames, increases as the fourth power of the temperature, hence boilers which have worked satisfactorily, but inefficiently, with a comparatively low furnace temperature, even though the plates may be covered with scale or grease, are likely to give trouble if the furnace temperature, and with it the efficiency, are increased. It is not strictly true to say that scale and grease reduce the efficiency of a boiler; they merely make it unprofitable to adopt an efficient system of combustion.

Slow bulging of the furnaces may be caused by the deposition of scales of crystals from any boiler water containing more than 4 per cent. of soluble salts. It is more than probable that plates which on one side are exposed to an intense heat, are on the other side covered chiefly with bubbles and sprays of burst bubbles, which leave their dissolved salt on the boiler plate while the water is evaporated. If the intense heat and rapid evaporation can be maintained locally, and this seems to be the case if mechanical stokers are worked very hard, crusts of salt will form here and there on the heating surface. Sometimes they will be washed away with a slight change of evaporation or circulation, but sometimes they will remain attached to the plates for a sufficiently long period to cause overheating. Drops of water which fall on hot plates are in a spheroidal condition, do not wet the plate, and consequently will not dissolve any salt scale which has formed there. As soon as a little bulging has been effected, the salt crusts will doubtless break off, but as bulges are exposed to the flames more than other parts, salt crusts are likely to reform in them, and gradually the bulge grows larger and larger until it is detected. As soon as the fire is drawn the salt crusts are dissolved away, and the bulges are said to be due to mysterious causes. This danger is naturally greatest with boilers having a bad circulation.

BEHAVIOUR OF PLANTS IN RESPONSE TO THE LIGHT.[1]

IN the whole realm of biological science there is perhaps no phenomenon of greater fundamental importance than that exhibited by green plants in the transformation of carbon dioxide and water into starch and sugar. That this can only take place through the action of light upon chlorophyll is commonplace knowledge, but exactly how it is effected we do not know. Of the light that falls upon a green leaf a part is reflected from its surface, a part is transmitted, and another part is absorbed. That which is reflected and transmitted gives to the leaf its green colour; that which is absorbed, consisting of certain red, blue, and violet rays, is the source of the energy by means of which the leaf is enabled to carry on its work.

The extraordinary molecular complexity of chlorophyll has recently been made clear to us by the researches of Willstätter and his pupils; Usher and Priestley and others have shown us something of what takes place in chlorophyll when light acts upon it; and we are now beginning to realise more fully what a very complex photo-sensitive system the chlorophyll must be, and how much has yet to be accomplished before we can picture to our minds with any degree of certainty the changes that take place when light is absorbed by it. But the evidence afforded by the action of light upon other organic compounds, especially those which, like chlorophyll, are fluorescent, and the conclusion according to modern physics teaching that we may regard it as practically certain that the first stage in any photo-chemical reaction consists in the separation, either partial or complete, of negative electrons under the influence of light, leads us to conjecture that, when absorbed by chlorophyll, the energy of the light-waves becomes transformed into the energy of electrified particles, and that this initiates a whole train of chemical reactions resulting in the building up of the complex organic molecules which are the ultimate products of the plant's activity.

The absorption of light by the leaf is therefore of great physiological importance, and we have only to look at any of the plants around us to see how successfully they contrive to arrange their leaves to obtain the maximum advantage from the light that falls upon them. A plant organ responds to the directive influence of light by a curvature which places it either in a direct line with the rays of light as in grass seedlings, or at right angles to the light as in ordinary foliage leaves.

[1] Evening discourse delivered before the British Association at Manchester on September 9, by Dr. Harold Wager, F.R.S.

Formerly it was thought that the light acts directly on the part that bends, but the researches of C. and F. Darwin more than thirty years ago proved that in young seedlings this is certainly not the case. They showed quite conclusively by means of a large number of carefully contrived experiments that the heliotropic curvature in the lower part of a seedling is determined by the illumination of the upper part. Consequently no curvature can take place until a stimulus has been transmitted from the upper part, which behaves as a light-perceiving organ, to the lower part in which the motor response takes place.

Foliage leaves are not usually so sensitive to light as the plumules of young seedlings, and do not in many respects so readily admit of experimental investigations. We know that the leaf-stalk bends towards and tends to place itself parallel to the rays of light, and that the leaf-blade places itself at right angles to the rays of light. We know that when the leaf reaches the position of maximum advantage the movement towards the light ceases, and it then remains fixed, except for slight circumnutating movements, until either the direction of the light changes or its intensty is decreased. But we do not yet know—and the problem is not an easy one to solve—by what means the leaf is enabled to adjust its position to the direction of the rays of light, nor just how it perceives that it is or is not in the most advantageous position.

FIG. 1.—*Eranthis hiemalis.* Leaf stalks curving towards light coming in the direction indicated by the arrow.

Dutrochet suggested, without any experimental evidence to support it, that the lamina of the leaf exerts an influence on the movement of the leaf-stalk. Hanstein also considered that the lamina was the light-sensitive part of the plant, and even went so far as to compare it with the retina of the eye. C. and F. Darwin were the first to attempt to determine the point experimentally.

Pieces of blackened paper were gummed to the edges and over the blades of some leaves on young plants of *Tropaeolum majus* and *Ranunculus ficaria*; these were then placed in a box before a window, and the petioles of the protected leaves became curved towards the light as much as those of the unprotected leaves.

Rothert repeated Darwin's experiment on Tropæolum, and found that the leaves reach the right position whether darkened or not. Krabbe also showed by his experiments on Phaseolus and Fuchsia that when the leaf-blades were darkened the leaves reach the right position just as readily and as precisely as the undarkened leaves. On the other hand, Vöchting came to the conclusion from his experiments on Malva that the curvature of the leaf-stalk only followed when the blade of the leaf was illuminated.

Haberlandt concluded from his experiments on a variety of leaves that in some cases the lamina is the only percipient organ, that in others both lamina and leaf-stalk are concerned, and that in very few cases is the leaf-stalk or pulvinus alone responsible. He considers that when both lamina and leaf-stalk are concerned the larger movement is probably brought about by the leaf-stalk and the finer regulating movement by the lamina.

The experiments which I am about to describe are concerned in the first instance with the problem: Does the lamina perceive the light, or is the leaf-stalk the percipient organ, or do both take part in it?

The observations were carried out by a method suggested by the extremely ingenious and charming device employed by F. Darwin to prove that the geotropic sensitiveness of the plumule of a grass seedling is localised at the apex. It consists essentially in keeping the blade of the leaf fixed while the petiole is free to move. Thus if the blade of the leaf is kept in a horizontal position and then exposed to oblique light, what effect will be produced on the petiole? If it is free to move, the petiole ought to curve towards the light; and if the stimulus is localised in the leaf-blade, the curvature ought theoretically to continue so long as the stimulus continues to act and the petiole is capable of growth.

The experiment was first of all tried with a number of leaves of *Eranthis hiemalis.* The leaves were carefully removed from the plant; the blades were then attached to a glass plate, and the stalks were allowed to hang downwards in a glass vessel containing water.

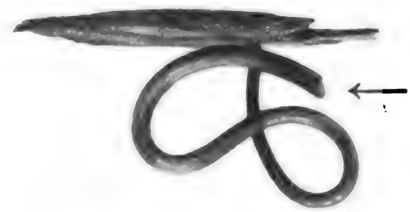


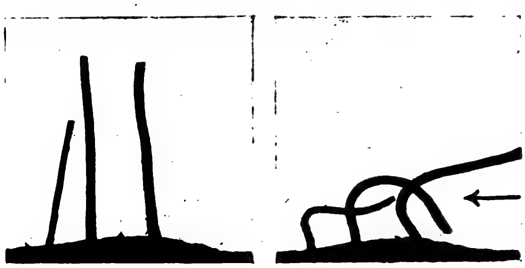
FIG 2.—*Tropaeolum majus.* Leaf exposed to lateral light and then turned round. The curvature of the petiole becomes reversed.

On exposure to an oblique lateral light the stalks very soon began to curve towards the light, and continued to curve in the same direction for several hours, until in many cases a complete spiral was formed (Fig. 1). Similar results were obtained with the leaves of many other plants. If a leaf in the petiole of which this heliotropic curvature has been induced is turned round so that the light impinges upon it on the opposite side, the curvature becomes reversed (Fig. 2).

The advantages of this method are that the leaves are not submitted to the rough treatment necessary to darken the blades or stalks, and, secondly, there is less interference with the respiratory and assimilatory functions. The disadvantages are that the leaf-stalks, being free to move, may be stimulated by gravity, and the pronounced curvatures thus induced may, unless proper precautions are taken, be mistaken for phototropic curvatures. So long as it is approximately vertical, the leaf-stalk is not influenced, or only slightly, by gravity, but immediately it moves from the vertical in response to the light stimulus, the influence of gravity comes into play, and light in conjunction with the gravitational stimulus takes a share in effecting its curvature. As soon, however, as the leaf-stalk in its upward movement passes beyond the vertical, the gravitational stimulus tends to bring it back to the vertical position, and the light stimulus then, in order to effect any further curvature, has to continue its action against the force of gravity.

A striking experiment to show that curvatures may be effected by the phototropic stimulus against the gravitational stimulus was made by placing leaves upside down. Three young leaves of *Eranthis hiemalis* had their leaf-blades securely fixed between two pieces of black cardboard, the leaf-stalks passing through small holes in one of the pieces of card. The leaves were then placed with the stalks projecting upwards in water in a rectangular glass vessel. Three sides of the glass were darkened, the other side was exposed to a dull lateral light. In the course of the day (Fig. 3) the stalks curved distinctly towards the light against the force of gravity which tends to keep them vertical.

In all these experiments the light was allowed to act upon the whole of the leaf, both blade and leaf-stalk, but as in many cases the leaf-stalk itself is phototropically sensitive, it was important to determine to what extent either of these organs, submitted separately to the influence of light, might bring about the curvature. Accordingly, experiments were made by which the leaf-blades only were exposed to oblique light. This was done by fitting a light tight cover over an opaque vessel containing water. The stalks of the leaves were passed through small apertures in the cover and allowed to hang down in the water. The blades resting on the surface of the cover



a *b*

FIG. 3.—*Eranthis hiemalis.* Three leaves placed upside down, with their stalks vertical (*a*); on exposure to light they curved towards it (*b*).

were then covered with a piece of clear glass and exposed to the light. After some time the stalks were found to be curved more or less in different directions, no doubt due to the geotropic stimulus, but there was no definite curvature towards the light, although in many experiments the leaves were exposed to the light for a week and even longer.

When, however, the leaf-stalks are exposed to the light and the blades kept in the dark, the stalks all curve distinctly to the light. A large number of leaves belonging to different families of plants was tested in this way, and the result was always the same. The conclusion therefore seems justified that the perception of light is located not in the leaf-blade but in the leaf-stalk.

The further problem then arises: Does the whole of the leaf-stalk perceive the light or only a portion of it? Have we in the leaf-stalk, as found by C. and F. Darwin in the plumules of seedlings, a percipient region and a motor region separated from one another? To answer this question a simple piece of apparatus was devised, consisting of a shallow box about 10 mm. high, with a thin base and a thin top, leaving a space of about 7 or 8 mm. between them. This was open at one end, and fitted light-tight over an opaque vessel containing water. Through small holes in the top and bottom of the box the leaf-stalks were passed, so that the lower portions were in the dark, the upper 7 or 8 mm. at the apex of the leaf-stalk being exposed to the light. The leaf-blades resting on the upper surface of the box were covered with a piece of black card, and the apparatus was then placed in such a position that light rays entered the box and impinged upon the upper part of the leaf-stalks only. Before the experiment was started, however, in all cases the stalks were allowed to stand for some time in the dark until geotropic curvatures were set up; the position of the leaves was then so adjusted that the darkened parts of the leaf-stalks were all curved in the opposite direction to that of the light incident upon the upper parts.

Under these conditions the heliotropic stimulus was acting in opposition to the geotropic stimulus. The results obtained were most striking. The curvature towards the light was very marked, and distinct spiral curvatures were produced (Fig. 4).

From experiments made in this way on a large number of plants it was found that the apex of the leaf-stalk for a distance of a few millimetres behaves as a percipient region, and is capable of inducing a motor response in the lower part. Experiments were made to determine how much of the apical region it is necessary to expose to the light in order to obtain a response. Leaves of *Geranium pratense* and *Tropaeolum minus* were arranged to allow different

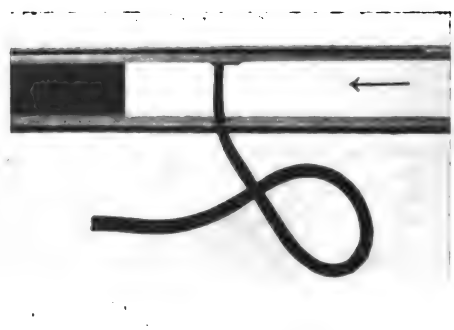


FIG. 4.—*Tropaeolum majus.* Upper 6 mm. of stalk only exposed to light. The direction of the light is indicated by the arrow.

lengths of the apex, 1 mm., 2 mm., 4 mm., 6 mm., 8 mm., and 10 mm. respectively, to be exposed to the light. A distinct response was obtained in each case, but the most definite results were obtained with lengths of from 4 to 10 millimetres.

We have now to consider briefly the mechanics of the movement. The curvature of the stalk is brought about by a more rapid elongation or growth on one side. The tissues of which the stalk is composed are all in a state of strain. The pith and vascular cylinder tend to expand, the cortical tissues to contract. Consequently if the stalk is split down the middle the two halves curve outwards, and, if placed in water, may coil up into a spiral. Now, how does the phototropic stimulus affect this state of strain? What will be the effect of splitting a leaf-stalk that has become curved under the influence of light? Will the two halves coil themselves up in opposite directions as before, or will it be found that the tensions have become modified, and the curvatures also modified in consequence? The experiment was tried on a number of different leaves, and it was found that in all cases the posterior half of the leaf-stalk retains the heliotropic curve, but the end of it tends to coil backwards as before. It is obvious that the light stimulus brings about a permanent change by which the relationships of the tissues to one another as regards their tensions are modified.

Now what will happen if a stalk is split before the heliotropic stimulus is applied? Will the stimulus affect the two halves, or will the posterior half remain

unchanged? To investigate this a leaf-stalk of *Geranium pratense* was split to within 8 mm. of the apex. The unsplit part was then exposed to light, the blade and the lower portion of the stalk being kept in the dark. The result shows (Fig. 5) that the stimulus received by the upper part of the stalk is transmitted to both halves, and the posterior half curves in the direction of the light. The end of the posterior half is, however, coiled backwards as before.

FIG. 5.—*Geranium pratense.* Petiole split to within 8 mm. of the apex and then exposed to light; the lamina was kept in the dark.

If we split a stalk into four we get the same result (Fig. 6); all the four separate parts of the leaf-stalk curve quite distinctly to the light.

Now arises the further interesting problem. If the leaf-stalk is split right up to the apex, will any effect of light be produced in the posterior half? A leaf-stalk split up to the apex was immersed in water for some time until a distinct spiral curvature was produced in both halves. The upper 8 mm. of the two halves were then exposed to light, one half being in front of the other, the blade and remainder of the stalk being kept in the dark. At the end of several hours' exposure to light, not only was the anterior half much coiled—due to the heliotropic stimulus and turgescence of the pith acting together—but the posterior half also showed a distinct curvature to the light in the motor region (Fig. 7). We find, therefore, notwithstanding the fact that two halves of

FIG. 6.—*Geranium pratense.*—Petiole split into four. All four parts curved to the light; the lamina was in the dark.

the percipient region, the anterior and posterior, are completely separated from one another, that the posterior half receives a stimulus as well as the anterior half, and that this determines in it a definite heliotropic curvature. Some attempt was then made to determine (1) what tissues of the stalk are concerned in the perception of light, and (2) the tissues through which the stimulus is conducted. In the first place, the epidermis of the stalk was completely removed and the upper 10 mm. of the stalk then exposed to the light, leaving the blade and the rest of the stalk in darkness. After several hours a definite curvature to the light was obtained, although not so pronounced as in an uninjured stalk. This was probably due to the rough treatment to which the stalk had been submitted by scraping off the epidermis. The experiment, however, shows that the epidermis is not essential either for the perception or the transmission of this stimulus.

Another leaf was then taken and the epidermis together with a part of the underlying cortex removed. In this case also, when the upper part of the stalk was exposed to the light, a definite curvature was obtained. Another leaf had the epidermis and the whole of the cortex removed, but in this case, even after an exposure of three days, no definite curvature to the light was obtained. These experiments indicate therefore that the cortical tissues are those mainly concerned in the perception and transmission of the stimulus. Further, several leaves were taken and transverse incisions were made on opposite sides of the stalk so that the tissues were completely cut across. Here also a distinct but not very pronounced curvature to the light resulted. It thus appears that

FIG. 7.—*Geranium pratense.* The petiole was split up to the apex. The posterior half as well as the anterior half curved distinctly towards the light.

although the perception of light is located in the cortex the stimulus can be to some extent transmitted transversally through the tissues, probably through the parenchyma and pith. That the pith is not necessary, however, was proved by splitting the leaf-stalk longitudinally into two halves and then removing by means of a sharp scalpel the whole of the pith, together with some small portion of the vascular bundles. On exposing the upper part of the stalk thus treated to the light, a definite curvature was obtained in both halves of the stalk.

It appears, therefore, from these experiments that the perception of light is located, probably, mainly in the cortex, but that the transmission of the stimulus may be conducted both longitudinally and transversally through any of the parenchymatous cells of the stalk, and that the motor response, although much more definite and pronounced when the whole of the cortex is present, can also take place when this is partly removed.

We may now ask, What is it that the leaf perceives, the direction of the light rays or the difference of intensity and the illumination on the two sides of the leaf? We cannot answer this question decisively; it is probable that both hypotheses are to some extent

correct. When the stronger light falls upon one side of the leaf-stalk, those cells on the side which is more illuminated are stimulated to activity to a greater extent than those on the less illuminated side, and the stimulus is transmitted to the motor region. Inasmuch as this stimulus is due to physico-chemical changes set up in the cells nearest to the light, the plant may be said to perceive a difference in the effects produced by the light on the two sides—that is, it is able to compare the two intensities. As soon, however, as the leaf reaches its right position, the apex of the stalk is illuminated more or less equally on all sides, and as the physico-chemical changes in the cells may now be considered to be more or less equal, no further stimulus will be transmitted, or, if so, will be transmitted equally all round the stalk, and no curvature in either direction will take place. The leaf now being placed in a definite position with reference to the direction of the light rays, it would seem quite justifiable to conclude that the plant is capable of perceiving the direction of the rays of light.

But the leaf is also capable of distinguishing between light of different wave-lengths. Notwithstanding the fact that rays of light both at the red end and at the blue end of the spectrum are absorbed, the plant responds phototropically mainly to the rays at the blue end of the spectrum, very slightly, possibly, in some cases to the red rays. This has been demonstrated by keeping plants behind different coloured light filters, and also in different parts of the spectrum. That this power is localised in the percipient region at the apex of the leaf-stalk can be very easily proved by exposing this percipient region to rays of the blue or red colour. The filters prepared and spectroscopically examined by Messrs. Wratten and Wainwright can be used for this purpose. Experiments were made with blue, green, and red filters. A strong curvature took place under the influence of the blue rays, but no curvature under the influence of the green or red rays, even when the exposure was continued for more than a week.

Here we have to do, therefore, with the quality as well as with the intensity and direction of the light rays, and the fact that the plant is more sensitive heliotropically to the shorter and more frequent vibrations at the blue end of the spectrum than to the longer and less frequent vibrations at the red end, indicates that it cannot merely be the direction of the light rays that is perceived. Moreover, we must remember that the plant does not respond directly to the action of light, but to the physico-chemical changes that take place in the photo-sensitive cells of the percipient region. We ourselves perceive the light because the brain is able to translate into sense impressions the physico-chemical changes which take place in the elements of the retina. The plant perceives the light because it is able to translate into a motor response the physico-chemical changes taking place in the photo-sensitive cells of the perceptive region.

We may imagine that in the plant the action is as follows: The light is absorbed by, and excites, certain photo-active substances in the cells of the sensitive region. A stimulus is thus set up which is conveyed through the cytoplasmic fibrils of the protoplasts to the motor region. A further impulse is then set up which acts upon the cells in the motor region, by which it is probable that changes in the permeability of the protoplasts are effected; the turgor conditions of the cells are thereby differentially altered, and the result is a motor response. We have here, in fact, a very simple type of reflex act taking place through the agency not of highly specialised nerve-cells, but of ordinary protoplasm and of the delicate protoplasmic fibrils which extend from one cell to another.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Prof. R. B. Clifton, who lately retired from the professorship of experimental philosophy at the end of his fiftieth year of service, has been elected to an honorary fellowship at Wadham College. He has been connected with that college ever since his appointment in 1865, and was an ordinary fellow for the thirty-two years previous to his retirement.

THE Secretary of State for India has appointed Mr. K. Zachariah to be professor of political economy and political philosophy at Presidency College, Calcutta; and Mr. W. A. Jenkins to be professor of physics at the Dacca College.

WE learn from the issue of *Science* for December 3 that objections have been filed to the will of the late Mr. Amos F. Eno, who bequeathed a large sum to public purposes and made Columbia University his residuary legatee. It is said that under the will Columbia University would receive 600,000*l*. or more. Our contemporary also states that a bequest of 10,000*l*. has been made to Cornell University by Mrs. Sarah M. Sage to promote the advancement of medical science by the prosecution of research at Ithaca.

WE have received from Washington a copy of a timely volume prepared by Mr. S. P. Capen, specialist in higher education of the United States Bureau of Education, entitled "Opportunities for Foreign Students at Colleges and Universities in the United States." Students of education will find in it an excellent account of the present facilities for higher education in the States. Every kind of information that an intending student can require is provided. Prominence is given to descriptions of the organisation of a typical American university, living conditions, college life, and college entrance requirements. With reference to the expenses of foreign students, Mr. Capen points out that these vary widely at different institutions. Practically all the privately endowed institutions charge annual tuition fees. The fee is rarely less than 8*l*. a year for collegiate instruction, and in some cases is as high as 30*l*. or 40*l*. a year. Professional instruction, particularly in medicine and engineering, is still more expensive. The Massachusetts Institute of Technology charges 50*l*. a year, and to its students in naval construction and naval architecture 100*l*. a year. Most State-aided institutions charge only a small tuition fee to collegiate students not resident in the State, State residents being generally given free instruction. Living expenses, aside from tuition and other fees, vary with the location of the institution. As a rule, the fundamental charges—room, board, and laundry—are rather lower at country institutions than at those in the cities. The possible wide variations in price are indicated by the figure 18*s*. quoted as the weekly minimum by the University of Minnesota, and 2*l*. 8*s*. the weekly maximum mentioned by Cornell University. The incidental expenses of city living, including amusements, should, of course, also be reckoned.

ON December 9 Mr. Patrick Alexander, well known by his pioneer work in aeronautics, made over to the headmaster of the Imperial Service College, Windsor (Mr. E. G. A. Beckwith), the munificent sum of 10,000*l*. "for the furtherance of the education of boys of the Imperial Service College, *i.e.* for the training of character and the development of knowledge." Mr. Alexander had given to the college an aero-laboratory and equipment about five years ago, but owing to long absences abroad, and a serious illness, he has been unable to identify himself with the college of late as heretofore. Having, however, taken up his residence in Windsor for the last six months, he has been able to continue his research work in the labora-

tory that he so generously gave. It is interesting to note how quickly things aeronautical have progressed since Mr. Alexander's first gift. In the course of an address which he gave on that occasion he said "careful demonstrations with kites and gliders" had been made in connection with the laboratory which he had given, while to-day both kites and gliders have almost been forgotten! But though great changes have occurred, the tribute which he then paid to the Aeronautical Society of Great Britain is, if possible, truer to-day, while his closing words are peculiarly interesting now:—"There never was a time when England held a more dominant sway of mankind, and whether we have to fight on the seas, on land, or in the air, British brains and British boys are as good as they ever were, and the boys going through their training at this college will prove that Old England means to have and keep the supremacy of the air." Mr. Alexander has nominated as his co-trustees Mr. A. A. Somerville (head of the Army Side, Eton College) and Mr. E. G. A. Beckwith.

THE principal of the Northampton Polytechnic Institute presented his annual report at the distribution of prizes to the students on December 18. The report refers more particularly to the work of the session 1914–15. When the enrolments of students were made up at the end of the session, it was found that the total number of students during the session had been 1748, as against 2101 in the preceding session. As usual, the work has received the support of the trades affected. For the eleventh year in succession the principal has been able to place, without payment of any premiums, the whole of the second and third year engineering students in commercial workshops for the summer. In fact, this was easier than usual because by Easter the loss of skilled workers was making itself felt in all engineering trades. A roll of distinction which has been compiled shows that twenty-two members of the staff, 226 students, and 119 members of the polytechnic, making 367 in all, have joined the colours. Of these more than fifty have obtained commissions in one or other of the Services. The roll of honour shows the names of those who have given their lives for the service of their country or who have been wounded in that service. There are seven in the first category and six in the second. As regards the war work being done at the polytechnic, the report points out that courses for drafts from the artillery divisions of the new armies were organised and have been continued down to the present time. The courses consisted of classes in field telephony, in range finding, and in plane table work and map reading. Altogether 897 individual students have passed through these courses, and thanks have been received from Whitehall and from the divisional headquarters, as well as from individual brigades. The manufacture of munitions, also, has been undertaken.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Meteorological Society, December 15.—Major H. G. Lyons, president, in the chair.—F. J. **Brodie**: The incidence of bright sunshine over the United Kingdom during the thirty years 1881–1910. The author described the steady increase in the use of sunshine recorders from the somewhat crude type invented by Mr. J. F. Campbell in the early part of last century to the improved pattern of Sir George Stokes of 1879, which has remained in use with very slight modification to the present day. The paper is based on figures taken from appendix iv. of the *Weekly Weather Report* for 1913, published by the Meteorological Office, and the maps which have been constructed differ somewhat in detail from those appearing in the official volume. The author dealt with the prevalence of sunshine, both by the seasons in their usual grouping, and annually. He also referred to the average number of sunny days at Greenwich and Falmouth, and to the loss of sunshine recorded in London and other large manufacturing centres. He showed that the abatement of the smoke evil tended to an increased record of sunshine, and placed the large towns more on a footing of equality with the urban districts.—Dr. W. **Galloway**: Remarkable cloud phenomena. The author described the curious and rapid changes which took place in a small portion of a thundercloud, witnessed on July 31 last year near Ormesby Broad, Norfolk. The phenomena pointed to the occurrence of electrical discharges, but neither rain, thunder, or lightning occurred.

Royal Anthropological Institute, December 14.—Prof. A. Keith, president, in the chair.—J. Reid **Moir**: The evolution of the earliest Chelles palæoliths of the pointed type from the rostro-carinate implements. A series of ten flint implements from (*a*) the detritus-bed below the Red Crag; (*b*) the stone-bed below the Norwich Crag; (*c*) the Middle Glacial gravel of Suffolk; and (*d*) river-gravels in the Thames valley and at Warren Hill in Suffolk are described, and it is shown that the most primitive type of rostro-carinate has been evolved by gradual stages into the earliest Chelles palæolith of the pointed type. These stages are as follows:—(1) The substitution of a ventral plane formed partly by blows for the ventral plane composed entirely of cortex; (2) the gradual elimination, by flaking, of cortex from the ventral plane, and also the production of a dorsal plane by blows, and devoid of cortex; (3) the gradual reduction in width of the ventral plane until a cutting edge is produced, and the prolongation of the "keel" to the posterior region, accompanied by the disappearance of the dorsal plane.

Mathematical Society, December 9.—Sir Joseph Larmor, president, in the chair.—H. **Jeffreys**: The vibrations of a special type of dissipative system.—F. J. W. **Whipple**: Diffraction by a Wedge.—T. L. **Wren**: Some applications of the two-three birational space transformation.—T. C. **Lewis**: The circles which touch the escribed circles of a triangle.—E. B. **Stouffer**: Semivariants of linear homogeneous differential equations.

Institution of Mining and Metallurgy, December 16.—Sir T. K. Rose, president, in the chair.—E. A. **Wraight**: Influence of heat in cyaniding gold ores. The effect of heat on the dissolution of gold in cyanide solutions is a matter which hitherto has received but scant attention from metallurgists, and the author gives the results of a number of experiments which he conducted with a view to determining whether the application of heat would be beneficial or otherwise. His final deductions are:—(1) That the effect of heating cyanide solutions is of very doubtful benefit; the extraction may be increased for a short period, but this is more than compensated by the increased cyanide consumption and the subsequent decrease in the rate of dissolution of gold; (2) that oxidising agents (hydrogen peroxide excepted) are apparently of no value, and may even exercise a deleterious effect on the extraction; and (3) that the addition of oxygen in a more active form, either as hydrogen peroxide or by means of heated air, increases the solvent activity of cyanide solutions in a very pronounced manner.—A. W. **Allen**: Clay: its relation to ore dressing and cyaniding operations. The presence of clay in so many geological formations, and its invariable association with other metalliferous ores, makes the study of its properties of considerable importance with reference to reduction

processes. In this connection note has to be made of the distinct line of demarcation between colloidal and non-colloidal clay, the former state being inimical to filtration processes generally. After studying the various phenomena of the effect of weathering, adsorption and absorption of metals and of water during dressing and milling operations, their influence on specific gravity and the effect of heat on clay, the author deals with the viscosity of clay, its influence, and the use and value of electrolytes. He adduces from the facts premised in his investigation the highly absorptive properties of colloidal as compared with non-colloidal clay, and the powers which clays possess of retaining liquids and dissolved salts, and he draws the following conclusions :—(*a*) Adsorption of gold solution may occur during treatment, but the main loss is probably due to absorption. This conclusion is strengthened by the fact that (1) non-colloidal clay is only slightly absorbent; (2) colloidal clay is highly absorbent; and (3) burnt clay (*i.e.* after the colloidal envelope has been destroyed) is practically non-absorbent; (*b*) the weathering of clay slime should be avoided except in the instance where the decomposition of refractory mineral is desired; (*c*) clay slime should be allowed an extended time of contact with wash solutions. This precaution is, of course, unnecessary if the ore has been roasted before cyanide treatment.—E. **Maxwell-Lefroy**: Wolframite mining in the Tavoy District, Lower Burma. This is an informing paper dealing with the chief mineral product of the district. Nearly one-fifth of the total world's output of wolfram comes from Tavoy, so that particulars of the occurrence and methods adopted for mining and marketing the mineral should be of interest.

PARIS.

Academy of Sciences, December 6.—M. Ed. Perrier in the chair.—Ch. **Frémont**: A clock escapement of the thirteenth century. The description is taken from a manuscript dating between 1240 to 1251, by a French architect, Villard de Honnecourt. It is more than a century earlier than the clock made by Henri de Vic for Charles V., about 1370.—G. **Moch**: The double detonation of projectiles possessing a high initial velocity. Remarks on a communication on the same subject by M. Agnus, with references to earlier discussions of the phenomenon.—P. **Le Roland** and A. **Carpentier**: An induction apparatus for detecting metallic fragments.—Louis **Malctes**: Electrical influence in a cell with an insulating wall, and with liquid nucleus.—L. **Wertenstein**: The charge of the radioactive recoil.—L. **Tschugaeff** and W. **Khlopine**: The series of hydroxo-platinic salts. The new series is prepared by the action of ozone on Peyrone's chloride $(NH_3)_2PtCl_2$, in presence of ammonium carbonate. The general formula is $[Pt.5NH_3(OH)]X^3$, where X is Cl, (NO_3), etc. These substances have the property of forming insoluble carbonates and sulphates, and resemble barium salts in this respect.—M. **Fleury**: The subterranean hydrology of Alviella.—A. **Guépin**: Results of a shell wound of the brain. Surgical ablation or destruction of a third of the left cerebral hemisphere and subsequent recovery with appreciable nervous troubles resulting.—R. **Desplats** and R. **Paucot**: A radioscopic method for the localisation of projectiles.—Louis **Roule**: New researches concerning the migration of the salmon.—M. **Caullery** and F. **Mesnil**: The structure of a parasitic Copepod, *Xenocoeloma brumpti*, and its relations with its host, *Polycirrus arenivorus*.

BOOKS RECEIVED.

Elementos de Fisica Descritiva para a 4ª E. 5ª Classes. By Profs. F. J. S. Gomes and A. R. Machado. 5ª Edição, Revista by Prof. A. R. Machado. Pp. 528. (Braga: Livraria Escolar De Cruz and Ca.)

Rainfall of India. Twenty-fourth Year, 1914. (Calcutta: Superintendent Government Printing, India.)

Transactions of the Royal Society of Edinburgh. Vol. l. Part ii. Session 1913–14. Pp. 253–516+plates. (Edinburgh: R. Grant and Son; London: Williams and Norgate.) 27*s*.

The Romanes Lecture, 1915: Science and the Great War. By Prof. E. B. Poulton. Pp. 47. (Oxford: At the Clarendon Press.) 2*s*. net.

Live Stock Journal Almanac, 1916. Pp. 188. (London: Vinton and Co., Ltd.) 1*s*.

City and Guilds of London Institute. Department of Technology, Exhibition Road, S.W. Report on the Work of the Department for the Session 1914–15. Pp. x+451. (London: John Murray.)

Fourth Report on the Cost of Food in the Production of Milk in the Counties of Kent and Surrey. By G. H. Garrad. Pp. 95. (Wye: S.E. Agricultural College.) 2*s*.

New Zealand. Department of Mines. Geological Survey Branch. Bulletin No. 17. (New Series.) The Geology and Mineral Resources of the Buller-Mokihinui Subdivision, Westpart Division. By P. G. Morgan and J. A. Bartrum. Pp. viii+210. (Wellington: J. Mackay.)

Canada. Department of Mines. Geological Survey. Memoir 34: The Devonian of South-western Ontario. By C. R. Stauffer. Pp. v+341. (Ottawa: Government Printing Bureau.)

Metamorphic Geology. By C. K. Leith and W. J. Mead. Pp. xxiii+337. (New York: H. Holt and Co.) 2.50 dollars.

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THURSDAY, DECEMBER 30, 1915.

SCIENTIFIC RESEARCH AND CHEMICAL INDUSTRY.

THE future prospects of the British dye industry, and the organisation of it and other scientific industries, have been the subjects of much attention lately. The developments taking place in Japan, Russia, Italy, and America in regard to the manufacture of synthetic dyes were discussed by Dr. F. M. Perkin in a lecture recently delivered before the Society of Dyers and Colourists at Bradford. The latest American enterprises in this industry were described in NATURE of December 16, p. 429, and the conclusion was drawn that, in a few years, America will be very largely self-contained in the matter of dye wares. This condition may, with reasonable certainty, be postulated of the other industrialised countries, including France, and, one may hope, the British Empire. If this anticipation be realised, it will mean that the synthetic dye industry, with all the allied trades in fine chemicals, will have entered on a new phase of their development. Before the war these industries were very largely a German monopoly. After the war they will be comparable with the brewing and distilling trades in that the wants of each industrialised nation will be supplied almost entirely by manufacturers of the same nationality. Only a few dyes or fine chemicals having specially desirable properties will find their way across the frontiers, just as is now the case with alcoholic beverages of international reputation.

So far as the existing dyes and fine chemicals are concerned, there can be little doubt that in the course of twelve months or so processes will have been worked out for the manufacture of these products on an industrial scale. At first it will certainly not be found possible to produce these materials so cheaply as was formerly done by our German rivals. Both the capitalists and the consumers will need at first to exercise considerable patience and forbearance. Later, as technical experience increases, the cost of production will certainly diminish. But even if all the synthetic products on the market before the war are captured in this way and manufactured at a reasonable price, this development, although representing a considerable advance, will not suffice to ensure the continued stability of the chemical industries. There are no ideal dyes, drugs, or other fine chemicals; all are capable of improvement, and, in spite of the distractions of the war, many German chemists are engaged in the amelioration of existing chemical products. Only quite recently the report has filtered through of a further considerable advance in the production of synthetic indiarubber. These developments call for corresponding efforts on our part, and the demand arises for more and better-trained chemists.

The view has been put forward in certain quarters that now is the day of the chemical engineer. It is undoubtedly true that a chemist with some mechanical aptitude will find a useful outlet for this bent in the chemical factory, but unless he exercises the trained chemical mind, and the synthetic ability to make chemical discoveries, he will never have the problems on which to utilise his engineering talents. Perkin's mauve, Meldola's blue, Knorr's antipyrine, Ehrlich's salvarsan, Baekeland's baekelite, and many other valuable discoveries were made by chemists working at these problems from a purely chemical point of view, and although some of these eminent investigators may have had more or less mechanical aptitude enabling them to put their discoveries into operation on a more extended scale than in the laboratory, yet the indisputable fact remains that they made these discoveries first and foremost because they were trained chemists with the chemical insight into the molecular constitution of the materials they studied. As a conneting link between chemist and engineer, the chemical engineer may serve a useful purpose, but he can never become an efficient substitute for the chemist. The latter alone with his own hands, and usually with cheap improvised apparatus, makes the synthetical discoveries which then become the factory problems for the engineer.

As regards the organisation of chemical workers for industrial research, it must not be assumed that conditions applicable to Germany will be readily adopted in the United Kingdom. Due regard must be made for the highly developed individualism of the British character, with its sporting instincts, its love of personal liberty, and its disinclination to sink natural predilections and to take the point of view of the State. It is useless to deplore these apparent shortcomings of the national temperament; indeed, in certain contingencies they are to be regarded rather as virtues. This preference to fight for one's own hand has probably, in many a recent desperate battle, kept intact the thin extended khaki line against overwhelming hordes of more amenable

individuals who have acquired the pack habit. Yet while we cannot but admire the instinct for individual action thus displayed, it must be confessed that success in modern conflicts—military or industrial—is mostly commanded by disciplined forces organised for co-operative effort against the common enemy.

At a meeting of the London Section of the Society of Chemical Industry held during November, a long discussion took place on Dr. M. O. Forster's suggestion that a chemical intelligence department should be instituted by the Government as a branch of the Board of Trade. Although the majority of speakers agreed that an organisation for chemical industry was necessary, there appeared to be a disinclination to entrust the Government with control of this department. A scheme for a co-operative organisation established by the chemical industry itself had already been advocated in September by the *Chemical Trade Journal*. This development, although a consummation devoutly to be wished, scarcely seems practicable in view of the separatist tendencies which still manifest themselves from time to time, both in the chemical profession and among chemical industrialists.

After the war much of the plant newly erected for the manufacture of high explosives will be available for the production of synthetic dyes and other fine chemicals. The relationship between these factories and the existing chemical works will need to be dealt with sympathetically and impartially by a competent authority, otherwise much loss of capital and energy will ensue as the result of competition between organisations working on similar lines. The elimination of this internal friction in our chemical industries would be a useful function of the suggested chemical intelligence department.

Many reasons have been advanced to explain our inability to develop the industries based on chemical synthesis. Taken separately, these factors are inadequate to account for the failure. Collectively they are effects of a fundamental cause discovered in early-Victorian times by Justus von Liebig, who, after a visit to these islands, declared roundly that "England ist nicht das Land des Wissenschaftes." One may well ask what chance have we of reforming in this respect? A gleam of hope arises from the following consideration. Formerly the advantages of a German university training were confined to 1851 Exhibitioners and to a few of the more well-to-do among us. To-day considerably more than a million of our fellow countrymen, drawn at an impressionable age from every station in life, are pursuing their scientific studies at an open-air German university under conditions which compel their undivided attention. Many of them realise very forcibly that the advantages possessed by their enemy instructors are due entirely to scientific organisation. When our soldier-students return to civil life will they insist upon scientific control of all national affairs? In that possibility lies our strong hope.

THE MOLECULAR VOLUMES OF LIQUIDS.

The Molecular Volumes of Liquid Chemical Compounds from the point of view of Kopp. By G. Le Bas. Pp. xii+275. (London: Longmans, Green and Co., 1915.) Price 7s. 6d. net.

TO anyone interested in the progress and development of science in this country, and in the attitude of the general community towards it, it is a significant and welcome sign that English publishers should now be found willing to undertake the issue of highly specialised works of the kind under review. For nothing would seem more clearly to indicate the spirit which is gradually coming over the community than the fact that there should be a demand, even if limited, for such a book. No doubt this demand has been stimulated by the influence of the more active and progressive teachers in our universities and leading schools of science. This series of monographs on biochemistry, physics, and inorganic and physical chemistry, comprising up to now some three dozen volumes, each the work of an eminent specialist, marks a new departure in the scientific literature of this country. The books are not text-books in the ordinary sense; that is, they are not intended to be used in or to accompany class-teaching. They are addressed mainly to those who have already passed through lecture-room courses, and who before embarking upon the work of investigation in some particular branch of experimental inquiry are desirous of making themselves acquainted with the present state of knowledge in that special department. Their publication at the present time is most opportune.

The titles of some of the volumes may not, at first sight, suggest that they have any practical bearing upon the problems with which we are more immediately confronted. But to disparage them on this account is to take a very restricted view of their utility. As they deal, for the most part, with what may be called frontier—or pioneering—work, they are of the very greatest use to those who are bent upon exploratory

service. They may be compared to the maps which aid in the initial stages of an exploration; like all maps of a partially surveyed district, they may be imperfect and at times even erroneous; they indicate not only trodden paths, but suggest new routes; they serve to confirm imperfectly established facts, and lead to the correction of errors. It is almost a platitude to say that nearly every new departure in science seems at the time it is made to have no very obvious relation to the needs or conditions of our daily life. No one can possibly set a limit to the prospective usefulness of even the most recondite physical fact.

In the book before us, which has occupied nearly eight years in its preparation, Mr. Le Bas has brought together the results of the large amount of experimental work which has been spent upon the subject of the molecular volumes of liquid compounds since the time of Kopp, now upwards of seventy years ago. Kopp was not the first to attack this subject, but he was certainly the first to attempt to give a definite significance to the conception by seeking to establish the conditions under which proper quantitative values might be ascertained. Up to his time no rational method had been suggested whereby these values could be determined under presumably comparable conditions—say, at their normal melting- or boiling-points. Objections, of course, may be urged against the employment of either the melting point or the boiling point as a valid condition of comparison, but in Kopp's time no other course was open to him, and there can be no question that it did serve to bring out regularities and relationships which otherwise would have been wholly obscured. Kopp's example in this respect has been followed by almost every subsequent worker in this special field. It is with the large mass of material which has thus been accumulated that Mr. Le Bas's book mainly deals, and it is for the reason that the work is fundamentally based upon the principles laid down by Kopp that the particular form of its title is due.

Of course, Kopp and his immediate followers suffered under the disability that present-day conceptions of chemical constitution were wholly unknown to them, and possibly even wholly undreamt of. These ideas are mainly due to a development of the chemistry of carbon compounds long subsequent to Kopp's day. Although Kopp made determinations of unimpeachable experimental accuracy on a number of organic compounds, his interpretation of the results they afforded was limited, and, indeed, occasionally erroneous, owing to his lack of knowledge of the effect of constitutive influences. He compared things between which we now know no real analogy exists, and made generalised deductions from wholly irrelevant and inconsistent data. The work of his successors was more or less guided by the light of contemporary theory, but, of course, even in their case it only reflects the state of knowledge or speculation at the particular period it was undertaken.

Now the great merit of Mr. Le Bas's monograph is that it not only collects and groups in a systematic arrangement the results of all the work hitherto published on the molecular volumes of liquid chemical compounds, but it discusses and seeks to interpret these results with the aid of all that is known or surmised concerning the constitution of such compounds, however it may have been ascertained. In this manner Mr. Le Bas has been able to give a great expansion and at the same time a greater precision to the conception of the intimate relation which indubitably exists between such a physical property as molecular volume and chemical constitution. Thus he shows, for example, that no physical property is apparently so well adapted to elucidate the ring structure of a compound as its molecular volume, and he expresses the hope that this will henceforward take its legitimate place among other physical properties as an instrument of research. That the determination of this value is readily possible, and with a degree of accuracy amply sufficient for its purpose as an indicative factor, had already been shown by the author. He finds that the values at the boiling point may be calculated with approximate accuracy by the following simple formula:—

$$\frac{d_0}{d_t} = 1 + c\left(1 - \frac{273}{\text{B.P}}\right)$$

the only data necessary being the density at 0° and the boiling point. The mean value of the constant c, as deduced from a considerable number of inorganic liquids investigated by the present writer, is 0·463. An almost identical value of c is obtained for organic cyclic compounds without side-chains. By means of the above formula the molecular volumes of liquid compounds may be calculated with an error of less than 1 per cent. In open-chain compounds the value of c increases by 0·024 for every addition of CH_2.

The book concludes with a suggestive summary of the theory of molecular volumes, in which the author discusses the present position of the additive principle, its value, and its limitations. He clearly shows, what, as he observes, had already been pointed out by the present writer, that there is a periodic relation in the atomic values of the various elements, and he illustrates this by a diagram, with special reference to the non-metallic elements. He summarises the discussion in the

main body of the work concerning the variations in the volumes of the atoms, more particularly in the cases of oxygen, sulphur, nitrogen, and chlorine. He traces the effect of constitutive influences, *e.g.*, the influence of the homologous increment, unsaturation, and ring structure; valency, and groups; and lastly he discusses the special conception embodied in molecular volume and its relation to other physical properties, such as boiling point, surface tension, and viscosity.

The book is by no means easy reading, but it bears on every page the evidence of thoughtful, critical insight, and may be unreservedly commended as a faithful and accurate digest of the state of present knowledge upon what is confessedly a complicated and intricate subject.

T. E. THORPE.

THE PARTITIONS OF NUMBERS.

Combinatory Analysis. By Major Percy A. MacMahon. Vol. i., pp. 300. (Cambridge: At the University Press.) Price 15*s.* net.

THOSE who, like the present writer, have been privileged to hear Major MacMahon give an account of his methods of solving the problems of which the well-known Latin Square is typical—problems of interest to many who are not professed mathematicians—have been waiting for this treatise with eagerness. Volume i. has now appeared, and it amply fulfils the expectations which have been formed. If we may quote from the preface, the object of the work is to present to mathematicians an account of theorems in combinatory analysis which are of a perfectly general character,' and to show their connection as parts of a general doctrine. The modesty of the author forbids him to mention that the greater part of the work is his own, as well as most of the important theorems which are treated. It is fair to say that Major MacMahon has developed a new line of mathematical work, and that many of the main theorems, rescued here for the first time from the author's papers in scientific periodicals, must form an essential part of text-books on higher algebra in the future.

The author enters a justifiable protest against the relegation of combinatory analysis to a part of the theory of numbers, for the theory is algebraical up to the point of determining the enumerating generating functions. He traces his method back to Laplace, who used these functions for the theory of probability, but he has greatly simplified Laplace's method by the extended use of symmetric functions.

The work is divided into six sections, each subdivided into a series of chapters. As a detail of arrangement, it would surely have been more convenient for a reader to find the chapters numbered consecutively throughout, instead of beginning again with each section. Section i. contains the theory of symmetric functions, and of distributions into parcels and groups in general, and it is especially notable in its clear account of the uses of Hammond's operators. The theory of separations is taken up in section ii., where an important generalisation of Girard's well-known formula is obtained. Permutations are taken up in section iii., where is proved what the author has ventured to call the "master theorem." This theorem really deserves such a title in a subject of this nature, and this section is, in fact, one of the most interesting in the book. The applications of the theorem to such problems as the sum of the *n*th powers of binomial coefficients are very elegant, and the chapter on lattice permutations is a very valuable piece of work. The theory of the compositions of numbers appears in section iv., and further applications of the master theorem are developed in this connection. Simon Newcomb's celebrated problem suggested by a game of "patience" is treated in a very attractive manner. Section v. takes up the question of distributions on a chess board, preceded by a discussion of the perfect partitions of numbers. This section will completely displace any other account of such problems, and shows the power of the analytical method very strongly. The sixth and last section is concerned with the enumeration of the partitions of multipartite numbers.

These brief references will serve to indicate the main outlines of the work, but they necessarily miss many of its characteristic features. The book is interesting even when the analysis becomes somewhat cumbrous, which the author allows it to do as little as possible. It is published by the Cambridge University Press, and maintains the tradition of excellence of this series. While congratulating the author, we hope that the second volume will not be long delayed.

THE TINTOMETER.

Light and Colour Theories and their Relation to Light and Colour Standardisation. By J. W. Lovibond. Pp. xii+90. (London: E. and F. N. Spon, Ltd., 1915.) Price 6*s.* net.

MR. J. LOVIBOND is known as the inventor of the tintometer. He has written no preface to the present book in the ordinary acceptation of the word, but commences with a chapter on "Purpose," which is largely devoted to enumerating the awards he has received from international juries and various scientific socie-

ties, and a list of industries which have adopted the tintometer. Mr. Lovibond tells us also that colour is "a determinable property of matter, and the purpose is to make known methods of colour analysis and synthesis which have proved of great practical value in establishing standards of purity in some industries." "The purpose is also to show that the methods (tintometer?) are thoroughly scientific in theory and practice," and also that "a new law (the law of specific colour development) has been developed." This is a new name for well-known observational results.

The first chapter has some introductory remarks, and there is a page and a quarter (with a coloured plate) devoted to what is headed "past" (colour) "theories." This does not give any novel matter, nor does it contain any criticism of the six theories which he enumerates. Chapter ii. is the most interesting of all, as it relates to the "evolution" of the tintometer. The tintometer is an admirable instrument for registering the colours of objects, opaque or transparent, which do not show pure colours. Its principle is to match such colour illuminated by white light by sending a beam of the same white light through one or more red, yellow, blue, and neutral-tinted glasses on to a white screen having various depths of colour till the colour of the object is matched. The choice of the glasses, and the skill with which Mr. Lovibond ground them to give the varying depths of colour which he required, approaches to the marvellous. His method of regaining his standard tints if lost is ingenious, so that observations made with the same quality of white light will always give the same results. The one weak point is the choice of the white daylight used, which is light from a north sky, that, of course, can vary in quality from day to day. A recognised standard of artificial light would be better.

Mr. Lovibond rather fights shy of the spectrum, and has given no results of matches to the band of spectrum colours by the absorption method. The spectrum throughout its length is unmatchable by this method.

When he makes statements regarding the spectrum analysis he sometimes gets out of his depth. He tells us that there is one red ray in the spectrum between A and B which cannot be absorbed, and that this (red) energy has never been investigated "as a separate form of spectrum red." Mr. Lovibond should look to the absorption by his glasses.

The book has its value when the theory part is left out, and may serve as a practical guide to "tintometry" through the useful examples which are shown in its later chapters.

OUR BOOKSHELF.

Field Analysis of Minerals for the Prospector, Mining Engineer, Traveller, and Student. By G. D. McGrigor. Pp. 86. (London: *The Mining Magazine*, 1915.) Price 3*s*. 6*d*. net.

THE methods of mineral determination here advocated by the author have been found useful by him as a prospector beyond the reach of laboratories. He has no doubt observed that a student who has passed through an ordinary course of chemistry is still poorly equipped for dealing with natural chemical compounds as they are presented to him in the field. In some colleges, however, the chemical curriculum includes a course in practical mineralogy, in which field conditions are, so far as possible, reproduced. Even Mr. McGrigor's book will not do away with the desirability of a sound course of inorganic chemistry as a prelude to such work as he marks out, and few will agree that this foundation should involve only "a very short period of instruction." The student of chemistry, for instance, will know that when Mr. McGrigor speaks of substances containing sulphur on p. 13, he means sulphides, and that there are also such things as sulphates; he will note the slip on p. 12, where the weight in air divided by the weight in water is said to give the specific gravity of a substance; and he will know (p. 19) that the oxidising flame does not "impart" oxygen to the material under examination. Possibly he will never have used microcosmic salt, and this is just where the author might have helped him (p. 22), by pointing out cases where it provides conclusive tests, instead of suggesting that it gives the same results as borax. Sir Warington Smyth is cited as the authority for some of these statements; but the author's practice must have led him somewhat farther.

The reactions described in the systematic portion usefully include those of tellurium, vanadium, osmium, and tantalum, which are omitted in many treatises. A just balance of simple wet tests and ordinary blowpipe-tests is indicated. The use of some good text-book on mineralogy is very properly recommended, especially Brush and Penfield's "Manual of Determinative Mineralogy," to which Mr. McGrigor's book may well serve as a pocket introduction.

G. A. J. C.

Egypt of the Egyptians. By W. Lawrence Balls. Pp. xvi+266. (London: Sir Isaac Pitman and Sons, Ltd., 1915.) Price 6*s*. net.

MR. LAWRENCE BALLS not only knows Egypt of the modern Egyptians, but during his years of residence there he bore his part in adding to her material prosperity. Indeed, he writes with authority on the problems of cotton cultivation, and while applying himself to their solution he formed opinions upon many other subjects connected with the country. This book is the result of such study and observation on the spot, and it is well worthy of study in its turn.

The chapters on the Nile, on irrigation, and the crops are perhaps its most valuable sections,

but the author is evidently a keen and thoughtful observer, and he has much to tell us on the reconstruction of the country. We fully agree with him that the real Egyptian of Egypt is not to be found in the towns but in the country villages, and we have been particularly interested in reading how he succeeded in training *fellahîn,* or members of the peasant class, to undertake the skilled work of observation required in an experimental garden, including the use of a chemical balance and other laboratory appliances. These later parts of the book are preceded by three chapters on the ancient history of the country. Here the author has no special knowledge, but he has in the main followed sound authorities, and the outline he gives serves as an effective foil to the account of modern developments.

Among the numerous half-tone plates, reproduced from photographs, several make effective illustrations and others are of technical interest. But a few are not of a distinctive character, either in subject or treatment, and, like the not very artistic representation of the Egyptian flag on the cover, scarcely do the author justice. Perhaps we are hypercritical. But first-hand information and experience of Egypt or the East are so rarely coupled in their record with a real sense of style; when we do meet them we are, perhaps, inclined to be ungratefully impatient of accessories which tend to disguise the combination.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

An Application of the Rules of Zoological Nomenclature.

MR. GERRIT S. MILLER, Jun., has published (Smithsonian Misc. Coll., vol. lxv., No. 12, November 24, 1915) the results of his investigation of a set of casts of the famous Piltdown fossils as compared with a large series of actual anthropoid and human skulls. Modern casts are made with great accuracy, and Mr. Miller is a competent and experienced authority on the skulls and teeth of mammals. He confirms the doubt already stated by many investigators as to whether or no the Piltdown lower jaw belongs to the same individual as the Piltdown skull, and goes further in the discrimination of the anthropoid character which has been obvious to all the investigators. He admits that the skull is human, but decides that the lower jaw is that of an extinct chimpanzee.

Mr. Miller's arguments are impressive, and may turn out to be convincing when they have been examined by persons who have seen the actual specimens. But Mr. Miller, who is also experienced in the application of the rules of nomenclature, has thought it necessary to name and describe a new species of chimpanzee, founding it on a jaw that he has never seen. Thus, if his opinion be sustained, the very famous Piltdown jaw, discovered by Mr. Dawson, made known to science by Mr. Dawson and Dr. A. Smith Woodward, and lodged in the British Museum, will have to be cited as the type of *Pan vetus,* Gerrit S. Miller.

P. CHALMERS MITCHELL.

Zoological Society of London, Regent's Park, London, N.W., December, 1915.

THE SCIENTIFIC ORGANISATION OF INDUSTRIES.

AN article by M. Jules Garçon on the scientific organisation of industries appears in the *Bulletin d'Encouragement pour l'Industrie nationale* for September–October, p. 383. After describing the proceedings of the deputations to Messrs. Pease and Runciman on behalf of the Royal and Chemical Societies, with representatives from the Society of Chemical Industry, the Society of Public Analysts, and the Institute of Chemistry, as the sequel to memorials presented to the Prime Minister on March 1, which have already been treated of in NATURE (May 13, p. 295), and giving a useful analysis of the various points raised, the sympathetic replies of the Ministers are alluded to. An account follows of the proceedings at the annual meeting of the Society of Chemical Industry at Manchester in July of this year, with reports of the addresses given by the president, Dr. M. O. Forster, Mr. Charles Carpenter, Prof. H. E. Armstrong, and Dr. Beilby. Next follows a summary of the address delivered by Sir W. Ramsay to the British Science Guild at its annual meeting on July 1, and, lastly, the details of the Committee and Advisory Council on Scientific and Industrial Research, appointed under the Board of Education.

M. Garçon sums up these various opinions and resolutions in several pages of "conclusions," which it may be useful here to indicate. The English men of science are unanimous in their view that the technical and scientific knowledge of the nation should be utilised to the greatest possible extent during the war, as well as to guarantee future progress. They demand the formation of a permanent central committee; that scientific investigation shall be encouraged; that the teaching of science in the universities shall be reformed; and that the scientific societies lend their aid to effect these changes. They demand *prompt* and *decided action.* The committee in connection with the Board of Education has now been appointed; it consists of men of acknowledged ability in science and industry, and is now busying itself with various items on the programme drawn up in accordance with the demands of the scientific societies. It has, besides, a very considerable annual grant to dispose of. It is the closer association of science and industry which is most to be desired, and an effort must be made to arrange university courses so that they will furnish young technologists able to experiment and to assist manufacturers. Centralisation is also imperative, for much has been lost in England for lack of concentrated effort.

M. Garçon notes that while the Société d'Encouragement, under the chairmanship of M. Léon Lindet, has done excellent work in succeeding in its attempt to induce chemical manufacturers in France to collaborate, and while in France there has been formed a "Union des Sociétés industrielles de France," also while in

the United States various engineering societies have collaborated as the "United Engineering Society," little is being done in this direction in Great Britain. The Society of Chemical Industry is attempting to collect a register of manufacturing chemists, but it is an expensive undertaking. It is, however, hoped that something tangible may be published in 1916.

There are obviously two questions, which, however, are closely related. First, how can the scientific and technical ability of the *entente* be utilised to the best effect in prosecuting the war? and, secondly, how can the efforts which Germany will undoubtedly make after the war to secure complete industrial ascendancy best be defeated? M. Painlevé, the French Minister for Education, points out the necessity for the best brains and the best plant in France being utilised to assist the Army and Navy. This war is more and more becoming dependent on engineers and chemists, and to conquer, all talent must be mobilised on a national footing. The excellence of the idea is obvious; the difficulties arise in arranging details. In England, too, it may be said that every man connected with science and industry is eager to do his utmost to help his country, but it is by no means easy to assign to each his task. Progress is, however, being made, although perhaps not so fast as might be desired.

The production of munitions of war goes on apace. Not merely are old and long-established works being driven to their utmost capacity, but large new works are being erected for the manufacture of chemicals required for war purposes. These are being well equipped with modern plant, and will turn out enormous quantities of such materials. But it is to be noted that the apparatus with which they are furnished differs but little from that required in many chemical works; tanks, steam coils, towers, stills, filter-presses, and the like are necessary, and are being provided. Now this raises a serious question. The war will not last for ever, and it would appear to be necessary to make arrangements for the utilisation of such plant and equipment, of labour and superintendence, when there is no longer a demand for thousands of tons of high explosives. The problem is a pressing one, and must not be long postponed. We cannot afford to "wait and see." It would be disastrous if, after the war, all staffs were dismissed, all plant scrapped and sold, and the whole organisation broken up.

The Committee under the Board of Education is a body charged with the furtherance of "industrial research." The object is admirable; but it appears to the writer that it is much more pressing to consider how to utilise these new and extended works in the future than to attempt to develop new and untried industrial processes, unless, indeed, these can be carried on in the munition works after the end of the war. The task is one of great magnitude. First and foremost, it involves coming into touch with every chemical manufacturer in the country and appealing to his patriotism to do his best, in conjunction with his fellows, to co-operate for the benefit of all. Is this possible? For there exists a feeling of mutual distrust, difficult, if not impossible, to eradicate; and this feeling is not unnatural. Even in well-known processes, improvements are constantly being made which may have the effect of rendering remunerative what would otherwise not pay. Often the "tips" are not patentable; often to patent them would be to give them away to competitors. Little wonder that the successful manufacturer has resolved on a policy of rigorously excluding the public from his works and patenting as few processes as possible. Our patent laws lend themselves to litigation, and litigation means loss of time and annoyance, if not loss of money. For this reason, too, the chemical manufacturer is not willing to co-operate with his fellows. He will tell what he sells; he will not tell what he makes. Yet it might perhaps be possible to induce at least a certain number of manufacturers to draw together for patriotic reasons.

In the uncertainty whether Protection will become the policy of this country, or whether the stocks accumulating in Germany will not be "dumped" in Great Britain at the close of the war, no one feels inclined to risk capital. Propositions for a customs union among the Allies have been hinted at, but are not as yet seriously discussed. Yet without such safeguards, or perhaps an even more drastic policy, German commercial aggression cannot be withstood. It will again be national organisation against lack of organisation. And even though the Hohenzollerns and the Habsburgs may be dethroned, it is too much to expect that the German nation will lose her power of acting as a whole, and bringing all her commercial and manufacturing combinations to bear on the commerce and manufacture of the Allies, with the view of annihilating them. For a time, patriotic societies may refuse to buy German goods; but such goods will be insidiously introduced through neutral countries under faked names, and before long the commercial war will be actively prosecuted. That is what we must look forward to, and it surely demands the most careful planning if we and our friends the Allies are successfully to combat such industrial warfare. The prospect is not pleasing; it is very difficult to face; and if we are to place ourselves in a position to do so, serious political changes are imperative in this country. The practical men *must* obtain control; they *must* be assisted by the highest scientific advice procurable. Moreover, all must co-operate for their country's good and for their own salvation.

It would appear to be the legitimate task of the Committee on Industrial Research to endeavour to make a beginning. If their powers are insufficient, let them be increased. They might add to their number men of affairs and industrial experience likely to be helpful. The most useful form which "research" can take at the present moment is the inquiry how our industries are to meet German attack after the war is over.

William Ramsay.

MOTHERCRAFT AND INFANT WELFARE.

NATIONAL existence is to a large extent dependent upon the quantitative value of the population, and diminution of population is the downward path which, if continued, must eventually lead to national extinction. The population of any country is the resultant of the balance between births and deaths and between emigration and immigration. In the British Isles, while emigration is a material factor in reducing population, the principal influence securing its continuous increase is the excess of births over deaths.

Unfortunately for the nation, a persistent and serious fall in the birth-rate in the United Kingdom has been in progress for many years, from 30·7 per 1000 of population in 1887 to 24·0 in 1913, and to 23·3 in the June quarter of this year. What this means is better seen from the actual number of births; in England and Wales alone for the last September quarter the births were 28,000 fewer than in the corresponding quarter of 1913! Fortunately, the natural increase of population during the same period has almost been maintained by a striking diminution in the death-rate. It is of interest that decline in the birth-rate is by no means confined to the United Kingdom, but has occurred in many countries on the Continent, the principal factor causing it here and elsewhere being a diminution in the size of the family, chiefly, apparently, in consequence of intentional restriction of child-bearing.[1]

We cannot anticipate any increase in the birth-rate at present, but rather a further decrease, for the toll exacted by the present war on the flower of the nation's manhood, the fathers and prospective fathers of her children, is sadly heavy.

It is of the utmost importance, therefore, that every means should be employed which may tend to maintain the effective fertility of the nation to the utmost practicable extent. If it be impracticable to increase the number of births, it is practicable to reduce still further the number of deaths of infants and children. As a matter of fact, infant mortality[2] has undergone a striking decline since the beginning of the century—from about 158 in 1900 to 105 in 1914. But, even so, the possibilities of saving child-life are by no means exhausted. If the chief causes of mortality during infancy and the first five years of life be examined, it will be found that one-fifth of the deaths in infancy and nearly one-third of the deaths in childhood are due to measles, diarrhœa and enteritis, whooping-cough, and tuberculosis. Bronchitis and pneumonia account for about one-fifth of the remaining deaths, and conditions operating at and before birth (premature birth, injury at birth, etc.) for another fifth. Measles and whooping-cough in themselves are not mortal diseases, the deaths arising mainly from exposure, inefficient nursing, and unhygienic conditions, and much may be done to reduce the mortality from these and the other diseases mentioned by improved care of the sick. It is evil conditions of environment, and not poverty only, which kill children and damage survivors; this is well shown by the variation of the death-rate among children in different parts of the community. In 1911–13 the infant mortality in Wigan was 165, in Nelson 87, and the death-rate at ages one to five in the same localities was 119 and 58 respectively. The children of miners, a relatively prosperous portion of the community, die at the rate of 166, of doctors at the rate of 40!

Unfortunately, during the last year the infant and child death-rates have shown an alarming tendency to rise, and during the first half of the present year the mortality from measles has doubled. It can hardly be doubted that this is largely due to the increased employment of women and consequent neglect of the home, and to the diversion of the activity of health visitors, district nurses, and others, who hitherto have done splendid work in helping to look after the children of the poor, into other channels more closely connected with the war.

With the view of reducing the mortality from measles, the Local Government Board has just issued an order making measles and German measles notifiable throughout England and Wales, and enabling local authorities to undertake measures for the care of patients suffering from these diseases.

A national campaign to promote the welfare of mothers and infants has also been inaugurated, and meetings were held at the Guildhall on October 25 and 26.

Municipal enterprises in the form of ante-natal clinics and maternity homes, infants' departments and milk depôts, feeding of expectant and nursing mothers, pre-school and post-school clinics, etc., should be encouraged in every way; what may be done in this direction is well shown by the example of Bradford, which has established departments in all these branches.[3]

Another factor which both lowers the birth-rate and tends to increase infant mortality is maternal mortality in connection with child-bearing, for obviously the mothers who thus lose their lives, had they lived, would in many instances have borne other children, while the infant is more likely to survive when cared for by its mother. In the four years 1911–14 the number of deaths of mothers assigned to complications of pregnancy and childbirth in England and Wales was 14,045, corresponding to a rate of 4·0 per 1000 births. The mortality among mothers due to child-bearing varies in different parts of the country. It is highest in Wales and Westmorland, and may there, perhaps, be ascribable to deficiency of skilled assistance in childbirth; it is also very high in textile areas, where female labour is largely employed. But the question is a complicated one, for we find that the mortality

[1] See "Report on Maternal Mortality in connection with Child-bearing and its Relation to Infant Mortality" (Rep. of the Med. Officer of the Loc. Gov. Board) for many of the data and details mentioned in this article.

[2] "Infant mortality" is the number of deaths of infants during the first year of life per 1000 births.

[3] See "Maternity and Child Welfare." By E. J. Smith. (P. S. King and Co.) Price 1s. net.

from child-bearing is practically the same in St. Helens and in Croydon—two towns which differ markedly in general social and sanitary circumstances, and West Ham, a relatively poor and squalid neighbourhood, has a rate lower than that of towns like Brighton, Bournemouth, and Hastings! When it is realised that the mortality from child-bearing varies from 8·54 in Dewsbury to 2·20 in West Ham, it follows that by the adoption of improved measures of care of the prospective mothers before and at childbirth, we may hope materially to reduce what is one of the most pathetic forms of loss of life. The care of prospective mothers is still more necessary at the present time, when there is such a considerable increase in female labour, and such care will, in addition, diminish the number of still-births and of damaged children born.

Not only the maintenance, but the further increase, of our present rate of increase of population must be regarded as one of the most serious and urgent of national problems and responsibilities at the present time. The child is now a national asset of great price, and for the successful rearing of the greatest possible number we must look to improved care of prospective and actual mothers, and improvement of mothercraft and of infant and child welfare. R. T. HEWLETT.

MEDICAL RESEARCH.

THE first annual report (1914–1915) of the Medical Research Committee has been published. It bears date October 18, which is very appropriate, because that is St. Luke's day, the day of the beloved physician. St. Luke's medical knowledge, doubtless, was that which Browning ascribes to Karshish: we have improved on St. Luke, so far as medicine is concerned. This report is a notable bit of work. The Medical Research Committee, as we all know, was born of the Insurance Act, and was endowed, at birth, with a penny in the pound. It was intended to study the diseases of civil and industrial life. It was born in August, 1913. A twelvemonth later came the war. *Pendent opera interrupta*—the work on the diseases of dangerous trades, the work on the commoner maladies of our big cities, was more or less declared off. The nation was thrown, all of a sudden, all unprepared, into that most dangerous of all dangerous trades, War.

In this crisis, this day of judgment—for that is the meaning, and the only meaning, of the Greek word crisis—the Medical Research Committee took a very wise course. It added to its first scheme of work a series of proposals for special work, to be undertaken by the committee, in direct connection with the war and for the assistance of the Army Medical Department; and it made up its mind that as the war goes on there will be less and less work to be done for the nation apart from the Navy and the Army.

Not only was the plan of work upset by the war, but the Central Research Institute, the buildings of the Mount Vernon Hospital at Hampstead, had to be transformed into the Hampstead Military Hospital. And, as the proposals for amalgamation with the Lister Institute, after very careful consideration, have been suspended, we might say that the Medical Research Committee is still without a proper home of its own. But it has found many temporary homes or resting-places for its work, and a welcome for it everywhere.

The researches into subjects connected with the war cover a very wide range. Work has been done at many of the general hospitals of the Territorial Force, and at other military hospitals. Valuable help has been given towards the preparation of the medical history of the war. Wound infections, typhoid and paratyphoid infections, and cerebro-spinal fever have been very carefully studied; so have many problems apart from bacteriology. Special interest attaches to Dr. Leonard Hill's study of asphyxiating gases, and to Dr. John Freeman's expedition to Galicia, whence he brought back cultures of strains of cholera-bacilli, for St. Mary's Hospital to make anti-cholera vaccines for the Serbian Government and for our Mediterranean forces; and to Dr. Leiper's discovery that a fresh-water snail is the intermediate host, between man and man, of the Bilharzia parasite. Other important studies include the work done on "neurological" cases, and the testing of British makes of salvarsan.

In brief, this report is a very fine record of good work done under most unexpected conditions. The moral is, that he or she who works for the forces of the Allies is working also, in the long run, for the nation at home. It is not a weakness, but an added strength, of science, that it can adapt itself to circumstances, and venture into new fields of research at a moment's notice. When the war is over, there will be time enough for the workers under the Medical Research Committee to come back to win other laurels for science in the ways of peace.

FOOD ECONOMY.

A NUMBER of useful pamphlets are being issued just now on how to economise in war time in the matter of food. One of these, by Prof. W. H. Thompson, of Trinity College, Dublin, we noticed a short time ago. The latest that has come into our hands, entitled "Food Economy in War Time" (Cambridge: At the University Press, price 6d.), should be widely read and acted upon. It is written by Profs. T. B. Wood and F. G. Hopkins, both of whom can speak with authority, one from the agricultural, the other from the physiological, point of view. It is written in a clear style, such as the man in the street, or, what is more important, the woman in the kitchen, can understand.

There are many in this country who cannot economise; they already exist on the minimum. Saving must therefore be accomplished by the comparatively well-to-do, and that this can be done without detriment to health is clearly shown.

It may mean some self-sacrifice, but self-sacrifice just now is the duty of all. There must not be recourse to expensive foods, the quantity of animal food must be reduced and replaced by vegetables, especially those rich in nutriment. Above all, there must be no waste, no throwing away, for example, of bones and dripping.

The little pamphlet is full of useful hints, based on accurate scientific knowledge and trustworthy statistics. The nation roughly spends 600,000,000*l.* per annum on its food. The authors estimate that it is not possible to save more than a tenth of this if due regard is to be paid to health and to the necessity of feeding children well at any cost. Sixty million pounds saved a year looks a large sum, but in these days, when millions are treated almost like sovereigns used to be, it will not be a very large fraction of the total necessary saving if the war is to be carried out to a successful end. Statisticians tell us that the ordinary savings of the nation in peace time amount to 400,000,000*l.* This will have to be increased to 1,600,000,000*l.*; and sixty millions is only one-twentieth of the additional 1,200,000,000*l.* which must go in the shape of taxes and loans to war purposes. The other nineteen-twentieths of this colossal sum must come from savings in other directions, or else the saving in food must be greater; we can only hope that Profs. Wood and Hopkins have placed their estimate too low.

SIR JOHN RHYS.

THE wonderful romance of the life of Sir John Rhys and the great work which he did for Celtic learning have formed the theme of many a writer during the past week. In the pages of NATURE it is appropriate to speak of the man as he appeared to his scientific friends. The dominant qualities of his mind, as they were again and again revealed in intimate personal contact, were a never-failing freshness and elasticity together with the keen insight which seized at once upon the larger problems. "Well, what has been going on in science lately?" was his invariable question when we met after an interval; and his deep interest was always there, whether the subject was radio-activity, or some new light upon heredity and evolution, or Arrhenius's hypothesis of life-bearing germs, persisting from the eternal past, permeating all space, and driven by the pressure of light to all the worlds. And it was just the same in the province where he was master. John Rhys was always looking for the big, far-reaching conclusions. Place-names in the Iberian peninsula were the data for inferring a former southward extension of the Basques; while their northern migration was tentatively suggested by the names of chiefs among the Picts, that mysterious people of which scarcely anything is certainly known. The present writer has heard him tell of the Irish chieftain of whom it is recorded in time-worn stone that he was "the summoner of the fairies"—evidence for a fascinating interpretation of an ancient folk-lore. The fairies, being an older race, living in caves and clinging to the hills, would still be called on by their conquerors, to assist, for example, in repelling some new invader. Such were the delightful subjects of which he talked with scientific friends, and those who would wish to trace, in brief compass, the working of his master mind, cannot do better than read and re-read his presidential address to Section H of the British Association at Bradford (1900), in which he "endeavoured to substitute for the rabble of divinities and demons, of fairies and phantoms that disport themselves at large in Celtic legend, a possible succession of peoples, to each of which should be ascribed its own proper attributes."

With regard to his methods, one little incident may be recorded. About five years ago Lady Rhys told the present writer of a recent journey in Spain, and how the Principal, although with no conversational experience of the language, went up to a man, and, without any hesitation, began to ply him with questions, reading them out of a Spanish conversation book. In this way, taking opportunities as they occurred, he made remarkably rapid progress.

As head of a college it was always his anxiety to promote friendliness and sympathy, and he must, I think, have been satisfied that his efforts were attended with success. The kindness of his heart was well known to those of his many friends who were in trouble, and they at least could dimly imagine the blank left by the death, in 1911, of the comrade who had trodden with him the noble journey of his life.

It is hoped that these few sentences will enable the reader to realise in part the important place held by this great man in the brotherhood of learning, and will reveal something of the affection and admiration felt for him by his friends, and especially by the society to which he brought such high distinction. E. B. P.

NOTES.

THE action of the Government in assigning a sum of about 30,000*l.* for the development of scientific and industrial research seems likely to have an important influence in British possessions overseas. The Commonwealth of Australia is apparently prepared to expend whatever sum is necessary to establish and administer an institution for such research, even if the cost amounts to half a million. The *Morning Post* of December 24 makes this announcement, but no details are given; and it is not clear whether the Premier of the Commonwealth expressed the intention of his Government to put aside the amount named for an institution of scientific research in relation to industry, or only gave a general assurance that such an outlay would be forthcoming when believed to be necessary. We shall look with close attention for the announcement that the substantial sum mentioned in the report has actually been granted for the establishment of a national laboratory in Australia.

THE funeral of Sir John Rhys, principal of Jesus College and professor of Celtic in the University of Oxford, was attended by a large and representative gathering of Welshmen, members of the University, and others. We learn from the *Times* that among the representatives of learned institutions and other public bodies present were Dr. Bradley (the British Academy), Principal Griffiths (the University of Wales and University College, Cardiff), Mr. D. Lleufer Thomas (Junior Deputy Chancellor, University of Wales), Sir Vincent Evans, chairman, and Mr. Edward Owen, secretary (Royal Commission on Ancient Welsh Monuments), Mr. W. Edwards and Mr. J. M. Edwards (Central Welsh Educational Board), Principal Roberts (University College, Aberystwyth), Prof. Morris Jones (University College, Bangor), and Prof. E. Tyrrel Green (St. David's College, Lampeter). The University of Oxford was represented by the Vice-Chancellor (the Dean of Christ Church), Sir Herbert Warren, many heads of houses, professors, and other members.

A MEMORIAL service for the late Sir Henry Roscoe was held on December 22 at the Rosslyn Hill Unitarian Chapel, at which the Royal Society was represented by the president—Sir J. J. Thomson—Prof. Arthur Schuster, Sir Edward Thorpe, and Prof. Smithells; University College (University of London) by the Vice-Chancellor, Sir Alfred P. Gould, Sir Thomas Barlow, Prof. M. J. M. Hill (chairman of the Academic Council), and Dr. Gregory Foster (the Provost); the Victoria University of Manchester by the Vice-Chancellor, Sir Henry Miers, and Prof. H. B. Dixon; the Chemical Society by Dr. Smiles and Prof. J. C. Philip (secretaries), and Lieut.-Col. A. W. Crossley (foreign secretary); the Society of Chemical Industry by Sir Boverton Redwood and Mr. Watson Smith, a former demonstrator in the Owens College, and late editor of the Journal of the Society of Chemical Industry; the National Physical Laboratory by Dr. Glazebrook and Dr. Harker; the Lister Institute by Dr. Harden; the Royal Commissioners for the Exhibition of 1851, Mr. Evelyn Shaw. Among others present were:—Lord and Lady Courtney, Lord Ashton of Hyde, Viscount Iveagh, the Master of Peterhouse, Sir A. W. Ward and Miss Ward, Sir Joseph Larmor, Dr. Emerson Reynolds, Sir William Tilden, Prof. Millar Thomson, Mr. Frank Scudder (late scientific assistant to Sir Henry Roscoe), Dr. Horace T. Brown and Miss Brown, Dr. Beilby, Dr. C. A. Keane, Dr. H. G. Colman, Dr. F. G. Ogilvie (director of the Science Museum, South Kensington), Mr. Gilbert Redgrave (secretary, Royal Commission on Technical Instruction), Dr. Aubrey Strahan (director of the Geological Survey of Great Britain), and Mr. J. S. Parkin, of the Castner-Kellner Alkali Co. The interment took place on December 23 at the Brookwood Cemetery, in presence of the immediate relatives, a few intimate friends, and representatives of scientific bodies. Among those who attended were Sir Edward Thorpe, Prof. Schuster, Prof. Perkin, Prof. Smithells, Dr. Harden, Dr. Keane, Dr. Colman, Mr. Chas. Cresswell, Mr. Reid, and Mr. Evelyn Shaw.

THE Local Government Board has issued an Order entitled "The Public Health (Measles and German Measles) Regulations, 1915," applying throughout England and Wales a system of notification of these two diseases, and enabling local authorities to undertake measures for the care of patients suffering from them. The Order, which comes into force on January 1, 1916, provides for notification of cases of measles and German measles to the medical officer of health of the district by medical practitioners, or by parents or guardians, or any other person in charge of the patient; these maladies are thus brought into line with several other diseases which have long been notifiable. Notification has been introduced mainly with a view to the control of the spread of infectious diseases, but has hitherto not been generally applied to measles, because the disease is infectious at an early stage, and before it can be definitely recognised. The powers provided by the present Order may tend to limit the spread of the disease, but they will probably be found much more useful in reducing mortality from it. On an average about 11,000 deaths from measles occur in a year in England and Wales, and these are confined chiefly to children under five years of age. Measles itself is not a fatal malady, death being due to complications—principally bronchitis, pneumonia, diarrhœa, and convulsions—which are largely brought about by undue exposure and inefficient nursing during the illness. As a result of notification the medical officer of health can adopt measures to reduce the proportion of fatal cases by rendering advice and providing nursing assistance to the poorest families.

WE regret to announce the death, in his ninety-second year, of Dr. H. Debus, F.R.S., formerly professor of chemistry at the Royal Naval College, Greenwich, and lecturer on chemistry at Guy's Hospital.

THE death is announced of Mr. W. Rupert Jones, who was for forty years assistant librarian of the Geological Society of London, and for a long period prepared the society's valuable annual record of geological literature. He was born in 1855, the eldest son of the late Prof. T. Rupert Jones, and retired in 1913.

SIR H. EVELYN OAKELEY, whose death is announced at eighty-two years of age, was the author of a treatise on algebra and geometry, a collection of mathematical problems, and many reports on educational subjects. At Cambridge he graduated as tenth Wrangler in the Mathematical Tripos of 1859, and was elected to a fellowship at Jesus College in the Midsummer term, 1860. From that date he continued in residence as fellow and mathematical lecturer until he vacated his fellowship by marriage in September, 1862. He was appointed H.M. Inspector of Schools in 1864, and Chief Inspector of Training Colleges in 1885.

THE *Glasgow Herald* of December 21 reports that a strong earthquake was felt on December 19, at 8.5 a.m., at Arrochar and Tarbet, the former being at the head of Loch Long and the latter at the head of Loch Lomond. The shock, which was of intensity 5 (Rossi-Forel scale) at Arrochar, is regarded as the strongest of those felt during the present century in

this district. The first, which occurred on September 18, 1904, also attained an intensity of degree 5. The disturbed area contained 564 square miles, its centre being nine miles west of Dunoon. A slighter shock (intensity 4) occurred on July 3, 1908. It was felt over an area of about 400 square miles, with its centre eleven miles north of Dunoon. The epicentre was thus displaced about fourteen miles in a north-easterly direction. From the evidence at present available, a similar further displacement appears to have occurred in the epicentre of the recent shock.

THE accounts of the local committee of the Manchester meeting of the British Association, held in September, lately issued, show that the resolution to observe the strictest economy in view of the exceptional circumstances in which the meeting was held was faithfully kept, and the local officers are to be heartily congratulated on the success of their efforts in this as in other directions. The expenditure amounted to only 862*l.* 15*s.*, and 22 per cent. was all that it was necessary to ask from the guarantors. On the occasion of the previous meeting, in 1887, the expenses reached 3652*l.*, and 35 per cent. of the much larger guarantee fund was called up. The meeting was in every way a success; it was attended by many eminent scientific men, the papers and discussions were of high value, and the arrangements gave such satisfaction that at the concluding meeting of the general committee many influential members expressed the hope that future meetings might be "run" on the same lines, excluding much of the lavish and costly expenditure on entertainments and excursions which has often proved a heavy charge on the local funds.

IN the House of Commons on December 20, Sir Philip Magnus asked the Minister of Munitions whether his attention has been directed to a recent resolution of the British Science Guild urging upon his Majesty's Government the necessity of immediate steps being taken to establish a national school of technical optics, with a view of affording opportunities for the scientific training in this country of artisans and other students in the theory and practice of the several operations needed for the manufacture of the optical instruments and appliances which have hitherto been largely imported from Germany, and are now being imported into this country from the United States of America and elsewhere; and, if so, whether he proposes to take any action in the matter. The question was answered by Dr. Addison as follows:—I understand that the resolution in question was passed by the British Science Guild in July, 1914. The object in view appears to be undoubtedly of the greatest importance, and my right hon. friend has had before him for some months the necessity for increasing the number of skilled workmen available for the manufacture of optical instruments for war purposes. I am advised that a considerable number are being trained at various works engaged on Government contracts. As regards the permanent supply of such workmen, I understand that the matter is receiving the careful attention of the Board of Education. Sir Philip also asked the Minister of Munitions whether he is aware that a small but efficient school of technical optics has been for some time in existence in connection with the Northampton Polytechnic Institute, Clerkenwell; that the governors of that school have purchased at a cost of 13,000*l.* a site for its extension, but have no funds available from which they can complete the necessary extension and equipment, and that unless funds are forthcoming they will be compelled to sell the site to avoid further payment of interest; and whether, in these circumstances, and having regard to the need of a well-equipped school, the Minister of Munitions can see his way to make a grant of money towards the further extension of the school. The answer given by Dr. Addison was:—I am sorry to hear of the difficulties with which the governors of the institute are faced, but the matter does not directly concern the Ministry of Munitions, and I regret that I cannot hold out any prospect of a grant from funds at the disposal of the Ministry. I understand, however, that the matter is under the consideration of the Board of Education and the London County Council.

AT the sixth annual general meeting of the Society of Engineers (Incorporated), held on December 13, the awards of premiums made in respect of papers published in the Journal of the society during 1915 were announced as follows:—The president's gold medal to Mr. A. H. Barker, for his paper entitled "Some Future Developments in Heating and Ventilation"; the Bessemer premium, value 5*l.* 5*s.*, to Mr. Alphonse Steiger, for his paper on "The Modern Development of Water Power"; a society's premium, value 3*l.* 3*s.*, to Mr. S. G. Turner, for his paper entitled "Law and Engineering; Some Points of Contact"; a society's premium, value 2*l.* 2*s.*, to Mr. F. Grove, for his paper on "Main Roads, Past and Present." The following were elected as members of the council and officers for 1916:—*President*, P. Griffith; *Vice-Presidents*, H. C. Adams, W. B. Esson, and W. Noble Twelvetrees; *Members of Council*, H. Adams, C. T. Walrond, F. L. Ball, B. Geen, the Rt. Hon. Lord Headley, F. H. Hummel, T. J. Gueritte, B. H. M. Hewett, G. A. Becks, and G. O. Case; *Associate Member of Council*, C. E. May; *Hon. Secretary and Hon. Treasurer*, D. B. Butler.

STUDENTS of eugenics will be greatly interested by Dr. C. B. Davenport's recent paper on the inheritance of violent temper (*Journ. Nervous and Mental Disease*, xlii., 1915, pp. 593–628). His results are taken from the study of 165 family histories of wayward girls in State institutions. From the facts, clearly set forth in the text and the pedigrees of eleven families in graphic form, the conclusion is drawn that "the tendency to outbursts of temper . . . whether associated with epilepsy, hysteria, or mania or not, is inherited as a dominant trait, typically does not skip a generation, and tends ordinarily to reappear, on the average, in half of the children of an affected parent." Hence it follows that "unaffected members of a fraternity who select an emotionally-controlled consort will only exceptionally, if ever, have affected offspring." This is comforting from the eugenic point of view, and some measures for isolating the worst of the "affected" might at least be discussed.

THE Irish Fisheries Office has lately published two interesting reports (Fisheries, Ireland, Sci. Invest., 1914, iii., iv. [1915]). The first of these, by Miss J. Stephens, deals with sponges from various localities around the Irish coasts, the Triaxonida (*Hexactinellida auct.*), the Tetractonellida, and the Astromonaxonellida. Forty-four species are enumerated, of which six are new to science, and twenty-six are recorded from the Irish marine area for the first time. Of special interest are a Biscayan and Azorean species of Hyalonema, *H. infundibulum* and *Leucopsacus scoliodocus*, hitherto known only from the Japanese Sea and Cape Verde. The other paper describes the results of a biological survey of Blacksod Bay, Co. Mayo, as compiled by Lieut. G. P. Farran, from identifications furnished by many workers at special groups. There are valuable faunistic and ecological observations, among which the influence of the neighbouring whaling station on the littoral fauna and flora is noteworthy. The equipment of the Blacksod station is so good that the detrimental effect of its refuse is confined to an area extending for at most 200 yards on either side of the quay.

THE Carnegie Institution of Washington has lately issued part i. of the third volume of Howard, Dyar, and Knab's great work on the mosquitoes of North and Central America and the West Indies. This comprises the first instalment of the systematic description of genera and species. The illustrative plates form vol. ii. of the work, which has presumably not yet been published, as we are unable to trace its receipt. According to the system adopted by the authors, all "mosquitoes" fall into a single subfamily—the Culicinæ—which, with the Corethrinæ and the Dixinæ, form the family Culicidæ. The Culicinæ are divided into two tribes: the Sabethini, comprising eight genera, and the Culicini, a very large and comprehensive group, subdivided into Deinoceritines, Culicines, Megarhinines, and Anophelines; the two last-named are not included in the part now before us. The work of Dyar and Knab on the structure of mosquito larvæ and its importance in classification is naturally prominent in this volume, and British entomologists will notice that many of the genera established by Theobald on characters drawn from the scaling are set aside. The systematic student will be greatly helped by the diagnostic tables provided, and he will find in all cases a very full synonymy. The introductory historical sketch of the classification of mosquitoes and the frequent accounts of the habits of the insects and their larvæ will ensure a welcome to the book from naturalists who are not specialists among these insects, especially in view of their great importance with regard to tropical diseases.

"VARIABILITY and Amphimixis" is the title of a recent paper by Prof. L. B. Walton (*Amer. Nat.*, xlix., 1915, pp. 649–87), in which he describes the result of observations on the varying sizes of zygospores in Spirogyra formed from "lateral" conjugation (fusion of two adjacent cells of the same filament), as compared with those formed from "scalariform" conjugation (fusion of two cells in distinct filaments). The zygospores resulting from the former process are relatively 26 per cent. more variable in length, and 31 per cent. more variable in diameter, than those resulting from the latter. Prof. Walton regards the scalariform conjugation as an example of sexual reproduction, and the lateral as a "quasi-parthenogenesis"; hence he argues, in opposition to Weismann, Jennings, and others, that "amphimixis . . . decreases and does not augment variability (cumulability), although amphimutability may temporarily be increased." The unfamiliar terms in this quotation are from the author's classification of variations, in which "amphimutations" are defined as "arising through the transference of factors by the combination of two ancestral lines in accordance with Mendelian principles, but exhibiting *per se* no definite progress"; while "cumulations" arise "through causes at present unknown, but which, from the progressive results obtained, may be assumed to originate in accordance with definite laws." On the other hand, Prof. Walton names four subdivisions of "abnormations" "apparently not originating in accordance with definite laws." The classification might be more valuable if the author would tell us exactly what he means by the phrase, "in accordance with definite laws."

THE value of the wood of *Cotoneaster frigida* for making the heads of golf clubs forms the subject of a letter from Sir Herbert Maxwell printed in *Kew Bulletin*, No. 9, p. 414. The wood has been tested for the purpose and found suitable, and may in time replace persimmon, which has succeeded crab and beech. *Cotoneaster frigida* grows easily in this country and seeds freely, but it takes some forty years to produce timber of suitable size. It is also probable that the wood of *Cotoneaster bacillaris* may be found suitable for making club heads; it also grows freely in this country.

IN *Kew Bulletin*, No. 9, Mr. J. H. Lace describes a number of new species from Burma, chiefly from the neighbourhood of Maymyo, and mostly of his own collecting. A large number of new species, including several new trees, have been discovered in this region in recent years owing to the activity of forest officers, and our knowledge of the flora of this region is far from complete. A new tree, *Allospondias laxiflora* (Anacardiaceæ), is among the more interesting of the plants described, as this tree, which is a conspicuous one on the dry limestone hills which rise suddenly out of the plains on both banks of the lower Salween, has been imperfectly known since 1862, when it was described by Kurz as a Buchanania. The original specimen was collected by Brandis, and apparently consisted of flowers only, and it is not known to what plant the leaves described by Kurz may have belonged.

COTTONSEED meal, the ground cake left after the oil is pressed from the seed of cotton, is now used extensively as a cattle food; but whilst it may be fed profitably to horses, cattle, and sheep in moderate amounts, poisoning, and often death, may occur as a result, especially if the animal has not been gradually accustomed to it. It is generally avoided in the case of pigs on account of the numerous deaths associated with its use. The toxic properties of the meal are attributed by Messrs. W. A. Withers and F. E.

Carruth (*Journ. Agric. Research*, vol. v., p. 261) to the substance *gossypol*, which was first isolated by Marchlewski in 1899, from the cottonseed, and patented as a prospective dyestuff. This substance is now shown to have a strong toxic effect upon all the animals experimented with. It occurs in the so-called "gland-dots," or "resin-glands," of the seed, and also in the cambium layer of the bark of the root. The problem that now awaits solution is to devise a means of rendering this substance non-toxic. Whilst gossypol can be readily oxidised to a non-toxic form, and can also be rendered harmless by iron salts, the seed tissue surrounding the cells prevents the free action of reagents, so that difficulty is presented in practice in rendering the cake innocuous by a simple treatment. This, no doubt, will be devised before long.

LAST April the American Philosophical Society held an interesting "symposium," resembling the joint discussions of the British Association, on the condition of the earth's interior. The three addresses given are now published in the recently issued bulletin of the society (vol. liv., 1915, pp. 279–308). Prof. T. C. Chamberlin studies the subject from a geological point of view, Prof. H. Fielding Reid describes the results and bearing of seismological investigations, and Dr. J. F. Hayford considers the earth from the geophysical point of view. The writers agree that the conclusions towards which we are tending are not yet firmly established. The methods of research were devised too recently to admit of dogmatism. But it is contended that the varied evidence afforded by geological, seismic, and tidal studies converges in favour, not only of a solid, but of an elastico-rigid, earth, in which liquid and viscous lacunæ, if any such really exist, must be confined to very moderate dimensions. Dr. Hayford's address is specially valuable owing to the many suggestions which he offers for further investigation.

AN important series of earthquakes began on June 22 in the Imperial Valley in the extreme south-east corner of California. They are described by Mr. Carl H. Beal in a valuable paper in the Bulletin of the Seismological Society of America (vol v., 1915, pp. 130–149). A slight fore-shock at about 7.40 p.m. on the day mentioned was followed by two severe earthquakes of intensity 9 (Rossi-Forel scale) at about 8 and 9 p.m. These earthquakes originated in nearly the same region, the buildings damaged by the first shock being completely destroyed by the second. Six persons were killed by falling walls, and the relatively small loss of life is attributed to the brief duration of the shocks and the warning given by the earlier of the strong shocks. Mr. Beal, who traversed the district by motor-car and collected information by means of the telephone, has drawn approximately a series of seven isoseismal lines of intensities 9 to 3. The first is an elongated ellipse about 10 miles in length; the last is circular in form, and includes about 50,000 square miles. The district is traversed by at least three major faults, trending in a south-easterly direction. The fault with which the earthquakes were connected is the San Jacinto fault. This is apparently a branch of the San Andreas rift, the great movement along which gave rise to the Californian earthquake of 1906. In the Imperial Valley, the course of the fault is hidden by recent deposits, which also obscure any permanent deformation that may have taken place at the surface. There is, however, some evidence for thinking that the San Jacinto fault traverses the epicentral district along the axes of the isoseismal lines.

THE Royal Geographical Society in its lectures and its journal keeps abreast of the times. From time to time instructive articles dealing with the areas of the war appear in the *Geographical Journal*. An exhaustive paper by Mr. Douglas Freshfield, on the southern frontier of Austria, appears in the December number (vol. xlvii., part 6). Mr. Freshfield discusses in detail the fighting which has taken place, and concludes that the Italian operations have intentionally been limited to defence in order to secure positions essential for repelling possible attacks on Lombardy or Venetia from the Trentine highlands. A number of maps show the present and proposed frontiers in relation to relief and nationality, and show clearly the justification of the Italian claims in the southern half of the Trentino and north of Trieste. The paper concludes with some account of the little-known frontier lands of Herzegovina and Montenegro.

IN his "Social Anatomy of an Agricultural Community" Mr. C. I. Galpin (Agricultural Experiment Station of the University of Wisconsin Research Bulletin 34, May, 1915) has made attempts in a new and important line of research in social geography. It is a study of the relation of farmer and townsman in the Walworth County of Wisconsin. This survey results in the delimitation of a number of agricultural communities, each with its village or city centre. The area of this nature, linked with the urban centre, may be designated as the country of that town or by the term greater prefixed to the town name, thus emphasising the close relationships of the two. Local government will be last, the author expects, to recognise these communities, and administrative areas give false boundaries. The interrelationships between the town and its country area disclose a mesh of correlated social interests uniting the city dweller and the farmer The rural problem thus becomes part of what Mr. Galpin designates the "rurban" problem. Neither rural or urban problem can be adequately discussed apart from one another. Various aspects of the problem are indicated, and the paper is full of suggestive ideas.

THE Monthly Meteorological Charts of the Indian Ocean issued by the Meteorological Office contain in each issue an ice-chart of the southern hemisphere for the ensuing three months, based on the records of the last eleven or twelve years. The ice-chart of the January, 1916, issue is fuller than usual, and gives the distribution of pack in the Antarctic Ocean in January, February, and March, in addition to the location of recorded bergs in past years. A long list is also given of the icebergs in the Southern Ocean for these three months from 1885 to 1915. The innovation on the chart is welcome, but it might be more thorough. Neither in the Ross nor Weddell Seas are the data complete. Off Wilkes Land there are no indications

of pack, and in the South Atlantic the ice-observations by Dr. Bruce in the *Scotia* are not incorporated. These latter might conceivably be of direct importance to merchant vessels; the others could affect only exploring ships. It is remarkable that while the extreme limits of ice approximate to the parallel of 40° S. in the Atlantic and Indian Oceans, records of icebergs are very few in the forties and fifties in longitudes east of Greenwich. In the Pacific, where the ice limits are further south, icebergs are numerous, as they also are in the waters immediately to the east of Cape Horn. The dimensions of some of the bergs recorded by merchant ships suggest probable exaggerations, but it would be impossible satisfactorily to edit these data, and so they must stand as given.

La Nature for December 4 has an interesting popular article on the methods of testing guns and ammunition, being the second article of a series on "Les Laboratoires de la Guerre." The first subject dealt with is the determination of the muzzle velocity of projectiles, measured by the well-known Boulengé chronograph; then follows a description of the crusher gauge and its use for measuring pressures in the gun. The apparatus in use in France for gauging the bore of the guns for possible distortion on firing and measuring the horizontal and vertical displacement after firing are described and illustrated. The stability on firing is a most important question, and is registered by means of suitable points attached to the gun and wheel axles which score directly on plates suitably placed in relation to the movement to be traced. With the latest Schneider guns it is stated that a glass of wine placed on the rim of the wheel is not upset on firing the gun. The velocity of recoil and return is measured by means of the tuning-fork method, the vibrations of the fork and travel of the gun being recorded on a blackened bar fixed to the top of the gun. The temperature attained on firing successive rounds is estimated by the use of a series of fusible crayons of chosen melting point to form a scale of temperatures permitting measurement to 20° C. An interesting feature of the article is the description of the drastic tests to which field pieces are subjected. At the Creusot factory four of the carriages are run by electric power over a circular track of *pavé*; at the Schneider works the carriage is drawn by an engine running alongside the test track over every conceivable object likely to be met with in the field, various road surfaces, ditches, railway lines, etc., and they are also tested under horse traction. In dealing with projectiles the degree of fragmentation is considered, and some illustrations given of the effect of shell fire on a field battery and on a concrete wall.

THE Research Laboratory of the Eastman Kodak Company at Rochester, New York, was organised in 1912, and in full working order early in 1913. Since then Dr. C. E. K. Mees and the staff working with him have published the results of their work in various journals in this country and in America, and as it is likely that many who are interested have not these journals available, the company has just issued a seventy-six page pamphlet, which contains abstracts of all the scientific papers published by them during the years 1913 and 1914. This step cannot fail to be appreciated by those who are privileged to receive a copy. There are three chief departments of the laboratory, namely, chemistry, physics, and photography. The pamphlet contains abstracts of twenty-two papers—none chemical. Perhaps the chemical work done is too intimately connected with the factory to justify its publication. The abstracts give the chief results obtained, and hence are useful without reference to the originals. The greater number of the abstracts are intimately connected with photography, and deal with such matters as sensitometry, colour processes, brightness of image, resolving power, etc., and some are of more general interest. L. A. Jones has investigated the utility of the standard acetylene lamp designed by Mees and Sheppard, which consists of an acetylene flame from a single jet and a diaphragm in front that isolates about 5 mm. of it. It is simple, requires but little attention, and is otherwise satisfactory. The "Colour of Illuminants," by L. A. Jones, "The Axial Chromatic Aberration of the Human Eye," by P. G. Nutting, "The Visibility of Radiation," by P. G. Nutting, are other papers which will appeal to many who may care but little about photography.

THE second series of Science Reports of the Tôhoku Imperial University, vol. iv., No. 4, contains a fifth communication "On the Chief Constituent of Japan Lac," by Rikô Majima. This is a remarkable compound, of a type that has not hitherto been found in nature, namely, an aromatic compound, with a very long aliphatic side-chain. The compound itself, which is described as urushiol, is unsaturated; but it can be reduced to a saturated compound, hydrourushiol, to which a definite formula can now be assigned, namely, $1:2:3\text{-}C_6H_3(OH)_2(C_{15}H_{31})$. The aromatic nucleus is of the familiar pyrocatechol type; but it contains a normal pentadecyl group attached as a long "straight-chain" to the nucleus in the position immediately adjacent to the two hydroxyl groups. The position of the double-bonds in the side-chain of the unsaturated urushiol is still undetermined.

AN account of the construction of some laboratory electric furnaces, given in an article in NATURE of December 16, contained a sectional diagram and a description of a single-tube furnace. The purpose of the article was mainly to explain the principles followed in the design of such furnaces; and Messrs. Gallenkamp and Co., Ltd., wish it to be understood that the diagram, which was drawn by the contributor of the article, should not be taken as an actual representation of the details of their patented furnaces. The specification of their laboratory furnaces of various types, with particulars as to performance, advantages, and prices, will be found in a special pamphlet (List No. 65) recently issued by Messrs. Gallenkamp, who will send a copy to science teachers and other workers engaged in instruction or research upon application being made to them at 19/21 Sun Street, Finsbury Square, London, E.C.

A CATALOGUE of books on Africa, just issued by Mr. Francis Edwards, High Street, Marylebone, deserves attention. In its classified lists are many books from the library of Mr. Charles Cowen, editor of the *Cape*

Monitor, and a large number of volumes dealing with the South African war of 1899–1902. The catalogue also includes more than sixty oil paintings by James Baines, who had a wide experience of southern tropical Africa, and was with Livingstone on his Zambezi expedition. The only other known collections of Baines's pictures are in the possession of the Royal Geographical Society and the museum at Kew Gardens. The catalogue is exclusive of Mediterranean Africa and the Red Sea border.

OUR ASTRONOMICAL COLUMN.

SUN-SPOTS AND PRESSURE.—A paper dealing with pressure data has been received from Dr. Gilbert S. Walker, who is engaged on a comprehensive statistical investigation in world meteorology with the object of laying the foundation of a secure system of seasonal weather forecasting. The data are treated as in the case of rainfall and temperature in preceding papers. For pressure the Indian area is characterised by negative correlation coefficients, whilst in the western hemisphere and boreal regions the opposite sign prevails. A general tendency is observable for the pressure coefficients to be opposite in sign to those for rainfall, indicating that their variations are dominated by a common cause, and temperature would seem to have little influence on either. Humidity, especially in the upper air, appears to control the relationship between sun-spots and temperature (Mem. Indian Met. Dept., vol. xxi., part xii., No. vi.).

HARMONIC ANALYSIS OF THE MOTIONS OF THE HELIUM STARS.—The dynamics of our stellar system are engaging an increasing degree of attention, and although Alcyone, and, recently, Canopus have been the suggested super-suns, it is still a question of establishing the existence of the general orbital movement. Prof. von S. Oppenheim adopts the working hypothesis that such movement exists, and some results of his work in this field were recently noted in this column (October 21). In an earlier investigation Prof. Oppenheim employed harmonic analysis to answer cognate questions. This is now recalled because these investigations have lately been carried a stage further (*Astronomische Nachrichten,* 4822). Pursuing the analogy drawn from the swarm of minor planets, he observes that a precise parallelism probably exists if instead of dealing with the totality of the stars the movements of the galaxy-grouping helium stars (type B) are alone taken into account. Employing the methods of the earlier papers to deal with the Lick results for the radial velocities of 233 stars of this type, taking proper motions from the Boss Catalogue, and making an approximation in regard to parallax, he finally obtains as developments of expressions involving respectively proper motions and radial velocities two Fourier series the terms of which are in good agreement regarding an orbital position angle of the sun, a result considered to establish the reality of the original hypothesis (*i.e.* that the stars, including the sun, move in circular orbits about one ideal centre). The numerical results which may be specially mentioned concern the position of this centre. Taking $\Omega = 234^\circ\ 40'$ as the ascending node of the plane of the sun's way, with inclination $i = 53^\circ$, then the sun viewed from the centre of the system appears in R.A. $203^\circ\ 55'$, declination $-34^\circ\ 9'$. The corresponding apex of the solar motion is R.A. 266°, and declination $+34^\circ\ 37'$.

THE ASTRONOMICAL AND ASTROPHYSICAL SOCIETY OF AMERICA.—We have received a copy of the second volume of the publications of this peripatetic society. The meetings reported range from the eleventh, 1910—attended by a number of important English astronomers—to the fifteenth, 1913. Abstracts are given of the papers. A most important feature of the volume is an appendix devoted to Halley's comet. The special committee of the Astronomical Society made suggestions that led to Mr. Ferdinand Ellerman taking an expedition to Honolulu to secure a record of the appearances presented by the comet during the spring of 1910. Two cameras were employed, a 6-in. Brashear, f.l. 31·8 in., and a Bausch and Lomb Tessar lens of 57 mm. aperture, and 251 mm. f.l. The greatest length of tail photographed with the latter was 50° on May 14. The photographs obtained are described by Prof. E. E. Barnard, and no fewer than forty-seven are reproduced. The dates range from April 26–June 6. The Comet Committee also publish a very extensive index catalogue of photographs of the comet, giving date, time of exposure, optical constants, place, and an indication of the technical quality of the photograph.

PROBLEMS OF EFFICIENT METHODS OF DOMESTIC HEATING.

THE determination of the efficiencies of different methods of heating is a problem very difficult to solve on a purely scientific basis. It is, indeed, difficult to attach a precise meaning to the expression "efficiency" in connection with heating apparatus. The word as commonly understood in connection with devices for the utilisation of energy in any form means the ratio of the total amount of energy utilised to that consumed. In a heating apparatus it is difficult to say what fraction of the energy is to be regarded as "utilised." If we regard that heat only as utilised which is delivered into *the air* of a room, in one sense every apparatus which when suitably disposed delivers almost the whole of its heat into the air of a room may be regarded as having nearly the maximum possible efficiency—100 per cent. Such, for example, is the electric low-temperature stove (not taking into account the generating mechanism or boilers from which the heat is ultimately derived), or the oil stove, or the gas radiator, which deliver the products of combustion into the air of the room.

But heat is delivered into a room not only by convection currents of heated air, but also by the conversion of radiant energy into heat. The proportion of the radiant energy which may be converted into heat is essentially uncertain. It depends on the position of the radiant body relatively to the windows, walls, furniture, etc., and on other circumstances. If therefore the "efficiency" of the apparatus depends on such extraneous considerations, it is evidently out of place to use, in connection with this matter, such a word as "efficiency," which has a precisely defined significance. Alternatively we are debarred from regarding the air heat as the only "utilised" energy.

Functionally, a heating apparatus is one by which a certain amount of heat energy is passed through a room to the outer air. As a consequence of its passage, certain thermal and other conditions in the room are maintained. If the resistance interposed between the room and the outer air is relatively high, the same flow of heat will maintain a higher temperature than if the resistance is low. In the limit if the resistance were supposed infinitely great, the thermal conditions might be conceived to be maintained without any expenditure of heat whatever. It

will thus be evident that the word "efficiency" in connection with heating apparatus can have only a relative and not an absolute significance. At the best we can only compare the efficiency of different methods of heating relatively. But even in this the difficulties are at least equally great.

The only possible experimental means would be to maintain the same room in the same conditions in the same circumstances by each of the two methods, and to compare the amounts of energy expended in the two cases. But different methods of heating produce in the room widely different and varying thermal results which are very difficult either to compare, control, detect, or even to define. In a practical experiment on an existing room, it is impossible to exercise any control over the out-of-door conditions, such as the temperature, the humidity, and the air movement, otherwise than by enclosing the test building in another outer shell. This at once makes the experiment unreal and artificial, and could only be applied to a very few specially constructed rooms.

As regards the indoor conditions, we have simultaneously and independently to control and to measure the interchange, the humidity, and the movement, as well as certain obscure electrical conditions of the air, the air temperature, and what may be called the radiant temperature, which is an entirely independent function. All these factors are extremely difficult, either to control with accuracy or to measure. They all vary in different parts of the same room; the variation of any one of them would be sufficient to vitiate the scientific accuracy of any exact experiment. The loss of heat from a room depends to a notable degree on variations in all such factors, especially on the uncontrollable exterior conditions. Even so apparently simple a function as the internal temperature cannot be obtained even approximately by that of a simple thermometer. This latter reading depends on the shape, the nature of the surface, the mass, and material, of the thermometer itself. The radiant temperature especially varies from point to point over the whole area of a room heated by a hot body within it. A scientific comparison would therefore be of so unwieldy a nature that it would be almost useless as a practical guide.

A practical comparison can only be made with the reservation that such a comparison would not bear the brunt of scientific criticism. It would be impossible without some pedantry to leave out of count the practical object of all systems of heating, namely, to render the room heated comfortable to inhabit. A system which did not produce this result would be valueless, however theoretically "efficient" it might be. This introduces variations of individual idiosyncrasy. What is comfortable for one person is not so regarded by another. The physiologist and hygienist have also to be heard on the question. Conditions which are often regarded as comfortable may be notoriously unhealthy. Amid this diversity of considerations, it is difficult to establish a basis even of relative heating efficiency without laying down arbitrary conditions which may have little or no relation to the real problems involved. It is evident that the conditions to be produced must be specified in terms of physics and chemistry, so as to take the matter out of the subjective region.

The temperature condition of a room is very uncertain and difficult to ascertain, as the naked thermometer is a very untrustworthy criterion of the temperature of the air; it is equally so of the feeling of warmth in a room. Indeed its reading in a heated room indicates nothing but its own temperature. It is possible to obtain from different kinds of correct thermometers at the same point in a heated room indications which vary by as much as 10° or 12°. The true air temperature at the same point may be far different from either of the two. It is impossible to say which of these is the "correct temperature" without laying down arbitrary conditions. Thus it is absurd to take the identity of the reading of ordinary thermometers on two separate occasions as an indication that the room is in the same temperature condition on the two occasions. If it could be proved that the identity of the thermometer reading produced a similar sensation of warmth the practical significance of this objection might vanish, but this is notoriously untrue. The feeling of warmth is an exceedingly complex matter, and can only be measured by a different instrument altogether—a kind of electrical calorimeter, which has to be proved by physiological experiments of the most difficult character to give a true criterion of the feeling of warmth.

It would be futile even to make any comparison without taking account of the interchange of air. To estimate or control this is as difficult an experimental problem as any previously alluded to. It can only be done by introducing into and thoroughly mixing with the air of the room known quantities of an easily recognised gas, and afterwards making periodic analyses of the air at intervals. Mathematical calculations based on the results of these observations will then give the actual interchange. This complicated determination must be made, otherwise any possible kind of test would be altogether untrustworthy. The interchange of air generally accounts for half the total loss of heat.

As a rough practical basis of comparison between different systems of heating, we may take the relative amounts of energy necessary to be employed in a room in order to produce the same feeling of warmth as measured by a suitably calibrated instrument (not a thermometer), while maintaining approximately the same interchange of air.

The subjoined table is based on direct experiment in this sense, and refers to the cost of continuous uniform heating in certain natural or normal conditions, the full description of which would occupy much space. An alteration of the conditions would undoubtedly alter the percentages given. These values cannot, however, in any event be taken as the *practical* relative costs, because of the manner in which the respective methods of heating are commonly employed in practice. A hot-water heater or anthracite stove is generally burning all the day and frequently at night. A gas fire or electrical stove is usually turned off when the occupant leaves the room. When these latter agents are so employed, the function of the heater is not to maintain a continuous constant temperature throughout the room, but to provide rapidly and temporarily such radiant conditions, that the region near the heater is in a thermal condition (including the radiant condition), tolerable for persons to sit there. There is a wide difference between this and the maintenance of a continuous temperature throughout the room, and a set comparison between the "cost efficiency" is therefore misleading. Indeed, a comparison of cost cannot be reasonably made without a good deal of definition of requirements. It is probable, for instance, that in certain circumstances a good gas stove is a cheaper method of heating an occasionally used room than is an anthracite stove, although the cost efficiency of the latter is far below (*i.e.* more economical than) the former.

In order to enable the running cost to be calculated at different prices of the fuel (including in that term electrical power), it will be desirable to quote the rela-

tive equivalents of different agents, as compared with 1000 Board of Trade units of electrical energy.

TABLE OF EFFICIENCIES FOR CONTINUOUS HEATING.

The rates given are those current in London previous to the war and at present:—

Approximate equivalents.		Nominal relative Thermal efficiency.	Rates per unit.	Gross cost £	Relative cost
Electric Radiator.					
1,000	Board of Trade Units of Electrical energy utilised in best radiant stove of 69% radiant efficiency disposed in the best manner .	Per cent. 100	1½*d.* 3*d.* 5*d.* 6*d.*	6·25 12·5 20·8 25	100 200 335 400
Open Fire.					
1·38 tons of best house coal, 14,000 B.T.U. per lb.	Burnt in bad grate unsuitably disposed.	8	26/- 35/-	1·8 2·42	29 39
0·520 ton best house coal, 14,000 B.T.U. per lb.	Burnt in best open modern grate sunk in wall	21	26/- 35/-	0·675 0·91	10·8 14·6
Closed Anthracite Stove.					
0·235 ton best anthracite, 14,500 B.T.U. per lb.	Burnt in best modern slow combustion, closed anthracite stove ...	45	40/- 50/-	0·47 0·59	7·54 9·42
Gas Stove.					
18,300 cub. ft. gas, at 520 B.T.U. per cub. ft. ...	Burnt in medium old-fashioned gas fire (not worst type) ...	36	2/6 3/-	2·29 2·75	36·6 44
10,700 cub. ft. gas, 520 B.T.U. per cub. ft. ..	Burnt in best modern ventilating gas stove	62	2/6 3/-	1·34 1·60	21·3 25·6
Water Radiators.					
0·198 ton of coke, 12,500 B.T.U. per lb.	Burnt in best provided modern water boiler with well-clothed circulation to radiators or pipes .	62	20/- 30/-	0·198 0·297	3·17 4·75
0·306 ton of coke, 12,500 B.T.U. per lb.	In usual small house hot water installation as generally installed	40	20/- 30/-	0·306 0·459	4·9 7·36
Oil Stove.					
19·5 gallons petroleum 0·87 gravity, 20,240 B.T.U. per lb.	Completely burnt in any kind of stove discharging products into air of room ...	100	8*d.* 10*d.*	0·650 0·810	10·4 13·0

ARTHUR H. BARKER.

THE PHYSIOLOGY OF INDUSTRIAL FATIGUE.[1]

THE gradual recognition of the prevalence among industrial workers of severe physical or mental fatigue has led during the last few years to a closer study of its harmful effects and to various suggestions as to its prevention. Although moderate fatigue is a healthy and natural event, there is little doubt that unduly prolonged hours of work, particularly if the work is carried on under unfavourable hygienic conditions, may lead to such a degree of fatigue that the efficiency and health of the worker are seriously impaired. The decline in efficiency manifests itself not only in a smaller output of work, but also in many occupations by an increased liability to accidents.

The prevention of extreme fatigue is, therefore, a matter of great importance, both to the employer and to the worker; but hitherto one of the most serious difficulties in the consideration of the problem has been the lack of any simple and certain test for the presence of fatigue. The question of finding a suitable index of fatigue has recently been taken up by Prof. Stanley Kent, and the preliminary results of his investigation are recorded in a report on industrial fatigue, which has been issued by the Home Office. Prof. Kent examined the influence of fatigue upon certain physiological phenomena, namely, the arterial blood-pressure, the reaction time in response to a simple stimulus, the acuity of hearing and of vision. The acuity of hearing was determined by noting the distance from the ear at which the ticking of a watch could be heard, and the acuity of vision was ascertained by noting the distance at which certain letters (test types) could be recognised.

The main experiments were carried out on three groups of workers—one group of six colliers, one group of six workmen in a chemical works, and one of six workers in the printing trade. The tests were applied twice daily, once before and once after the day's work, over a period of a week or more.

The experiments on the arterial blood-pressure and the reaction time yielded irregular and discordant results, but it was found that there was a striking diminution in the acuity of both vision and hearing at the end of the day's work, and that in many cases there was a progressive decline during the course of the week. The latter effect might be regarded as evidence of cumulative fatigue towards the end of the week. The decline in visual or auditory acuity was observed in all three groups of workers; in some members of each group the diminution amounted to 50 per cent. or more, whereas in others the change was so slight as probably to fall within the limits of normal daily variation apart from fatigue. The large variations in visual or auditory acuity in the same person on successive mornings, or on successive Monday mornings, when the subject was presumably not fatigued, are a prominent feature in Prof. Kent's results. These variations rather suggest that the subjective factor (as distinct from fatigue) is an important element in the test; and the fact that the test is purely "subjective," and that there is no means of checking the worker's statement as to the distance at which he hears a watch or sees a standard letter, is a distinct drawback to these tests.

Prof. Kent's observations also make it clear that, in some individuals, a day's work or a week's work leads to impairment of hearing but not of vision, or, on the contrary, to impairment of vision but not of hearing. This was noticed in each group of workers. It might be expected that, if the decline in visual or auditory acuity is a manifestation of general fatigue,

[1] Report on an Investigation of Industrial Fatigue by Physiological Methods. By Prof. A. F. S. Kent. (Home Office.)

both sight and hearing would be less acute in the fatigued person; and the fact that such is not always the case tells rather against the value of the tests as an index of fatigue. Taking into account, however, the comparatively small number of observations recorded up to the present by Prof. Kent, irregular results of this kind must be expected, and it is quite possible that a large series of observations would prove these anomalous results to be of minor importance. The simplicity of the tests and the ease with which they can be carried out is a strong argument for their adoption, provided that extended observation shows that they yield constant results.

THE CHILKA LAKE SURVEY.[1]

THE object of the memoirs referred to below is to inaugurate for the fauna of the brackish waters and waters of fluctuating salinity of the Indian coasts a register co-ordinate with that essayed by the *Investigator* for the Indian abyssal fauna. In the Chilka Lake, which is one of the best-defined and most strictly conditioned of these brackish tracts, and in the hands of such skilled explorers and many-sided zoologists as Dr. Annandale and Mr. Stanley Kemp, the undertaking makes a singularly happy inception.

The first instalment of the results of this Chilka survey contains a most interesting introduction to the topography and hydrography of the lake, and a detailed account of its Sponges, Cnidaria, Ctenophora, Oligochæta, Echiuroidea, Polyzoa, and Cirripedia: the introduction, the Echiuroidea, and the Ctenophora are the joint work of both authors; the short report on the Oligochæta is contributed by Col. J. Stephenson; for all the other groups Dr. Annandale is solely responsible. The second instalment is composed of four reports—on the Mysidacea, the Stomatopoda, the Mammals, Reptiles, and Batrachia, and the Aquatic Insects—the first being by Dr. W. M. Tattersall, and the last containing a contribution by Mr. F. F. Laidlaw.

The Chilka Lake is situated not far from the famous shrine of Jaganath at Puri, at the Mahanaddi Delta end of the tract of sand-waste, scrub, and screwpine-swamp that lies between the Ganjam hills and the Bay of Bengal. It is about forty miles long, with a maximum breadth of about sixteen miles, and a depth of a few feet; and in its origin it is a silted bay which—except for a mouth about 300 yards wide near the north-easterly limit—has been finally cut off from the sea by a narrow sand-spit formed (in the way usual along the east coast of India) by the strong northerly currents. By its narrow mouth it is in communication with the sea, while into the same north-easterly end run some of the waning effluents of the Mahanaddi Delta.

The survey under report embraced all the cardinal seasons of the year, and included 171 collecting stations. The observations show that in the wet season, when the Mahanaddi is in flood, the water of the lake is nowhere more than slightly saline, and over most of the area is quite fresh; while in the dry season it is nowhere anything but distinctly brackish, and in all the seaward area is as salt as the sea outside—facts of the greatest interest in their biological bearings.

The vegetation is considered mainly from the zoological point of view. Dense beds of Potamogeton give shelter to certain kinds of animals, and the leaves of a creeping Halophila afford anchorage to others; these are the characteristic water-weeds; for true seaweeds, of the higher kinds, are absent. At the water's edge there is little encouragement for sedentary organisms—no mangrove, and few screwpines, the most conspicuous shore-growth being a tall reed (Phragmites).

Beyond stating that the fauna as a whole is—as might be expected—mainly of marine origin, and specifying some distinctive features of the different habitats to which it conforms, the authors for the present make no generalisations outside the particular groups dealt with in their initial reports. Among interesting items it is noted that both fresh-water and marine sponges are found growing side by side, the former (Spongilla) being unable to resist high degrees of salinity, but the marine forms seeming perfectly comfortable in the wet season when the water is quite fresh; among the latter the world-wide *Cliona vastifica* and the Japanese *Suberites sericeus* are common, both producing gemmules in abundance. The Cœlenterates include eight or nine Hydrozoa, six Actinozoa, a Scyphomedusa, and a Ctenophore. The last, like several of the Hydrozoa, is a periodic visitor during favourable conditions; but the Scyphomedusa, though a common inhabitant of the Bay of Bengal, has established itself in the lake, and subsists, though in a state of repose, even when the water is quite fresh. Two species of Actinozoa (*Halianthus limnicola* and *Edwardsia tinctrix*) and one Hydrozoon (*Bimeria fluminalis*) seem also to be quite acclimatised, though the two first-named are inclined to be torpid, but with fecundity unaffected, in the fresh-water season. The barnacles of the lake belong to two widely distributed marine species, and also are inured to fresh water.

The common species of Squilla and all the four species of Mysidæ found in the lake appear to adapt themselves comfortably to all the seasonal changes of salinity. In the account of the aquatic insects, Mr. Laidlaw records as particularly noteworthy the existence in brackish water of the larvæ of an Agrionid dragonfly. The higher vertebrate fauna includes an otter, a dolphin (Orcella), the gharial and another crocodile, the hawksbill and edible turtles and a mud-tortoise, and three species of water-snakes.

The individual reports are instructive in fact and fertile in inference; all their regard for detail is infused with discernment; there is none of that assiduous piling up of wearying and bewildering minutiæ which so often makes eclectic work of this kind stale and unprofitable.

The memoirs are illustrated by numerous text-figures and twelve fine plates, which in the main are the work of those accomplished artists, Abhoya Charn Chowdhary and Shib Chunder Mondul.

[1] Memoirs of the Indian Museum, vol. v., No. 1, July. "Fauna of the Chilka Lake." By N. Annandale and S. Kemp. Pp. iii+146+plates. Price 15 rupees. Vol. v., No. 2, October. "Fauna of the Chilka Lake." Pp. 147–197+plates. Price 3.8 rupees. (Calcutta: Indian Museum, 1915.)

A VEGETATIVE CRUSTACEAN.[1]

EVERY text-book of zoology mentions, as one of the stock examples of degeneration, the curious cirripede, Sacculina, which lives as a parasite on crabs. Through the researches of Prof. Delage, more recently confirmed and extended by Mr. Geoffrey Smith, its life-history is now well known. After passing through free-swimming larval stages closely comparable with those of the normal barnacles, Sacculina attaches itself to its host and becomes endoparasitic, developing a system of branching roots which ultimately permeate all the organs of the crab. These roots radiate from a central mass of cells within which the sac-like body is differentiated, to emerge later on the surface beneath the crab's abdomen. While Sacculina is, as a rule, solitary, some related forms occur in considerable

[1] "On the Rhizocephalan genus Thompsonia, and its Relation to the Evolution of the Group." By F. A. Potts. Papers from the Department of Marine Biology of the Carnegie Institution of Washington, vol. viii., 1915. Pp. 32+2 plates.

numbers on a single host. The development of these has hitherto been something of a puzzle, since all the individuals found on one host are approximately in the same stage of development, and simultaneous infection by a swarm of larvæ seems improbable on account of the rare occurrence of the parasites. Mr. Geoffrey Smith, in 1906, made the suggestion that these gregarious parasites might be produced by some process of polyembryony or budding in the endoparasitic stage. He based the suggestion on the fact, observed by Delage and confirmed by himself, that the developing Sacculina may, as a rare exception, produce twin rudiments of the body within a single embryonic mass.

During the recent expedition sent by the Carnegie Institution of Washington to Torres Straits, Mr. F. A. Potts, of Cambridge, was able to investigate some of these "social" species of Rhizocephala and to obtain striking and conclusive evidence of the truth of this suggestion. The forms which he studied belong to the genus Thompsonia of Kossmann (with which he identifies Thylacoplethus of Coutière), and are parasites on various tropical crabs and shrimps. The saccular bodies occur in hundreds on the surface of the body and limbs of a single host, and are of much simpler structure than in the case of Sacculina. There is no mantle-cavity, nor are there genital ducts or associated glands, and the nervous system, reduced to a vestige in Sacculina, has entirely disappeared. Further, while Sacculina, like most cirripedes, is hermaphrodite, Thompsonia has no trace of male organs, and there is reason to believe that it reproduces solely by parthenogenesis. The sac-like bodies contain nothing but a mass of developing eggs or larvæ, which are set free in the so-called "cypris" stage, the earlier nauplius stage being suppressed. Mr. Potts was able to show that all the external sacs are in connection with a single continuous system of roots, and, further, that when the sacs are cast off by the moulting of the host (probably after their contained larvæ have been matured and set free), a fresh crop of sacs is budded off from the root-system.

It would scarcely seem possible to imagine a wider departure from our ordinary conception of an arthropod than that presented by Thompsonia, with its "mycelium-like root-system producing its singular asexual reproductive organs." Mr. Potts directs attention to the analogies it shows with certain Hydromedusæ. As if to complete the resemblance, he finds evidence that germ-cells are in some cases produced within the root-system, although he was unable to discover whether they migrate from thence into the developing buds as they migrate from the cœnosarc into the sexual buds of some Hydromedusæ. W. T. C.

CONDUCTION OF ELECTRICITY THROUGH METALS.[1]

THE power of transmitting large electric currents is one of the most characteristic properties of metals, and one to which they owe no insignificant fraction of their industrial importance. If we imagine for a moment the revolution that would be made in our daily life if metals did not possess this property, how much we rely upon it for light, locomotion, and communication, we shall realise how large a part it plays in our social life. It is not, however, on this aspect of metallic conduction that I wish to speak this evening, but rather on the mechanism by which the flow of current is produced, and the light which electric conduction throws on the structure of metals.

It is remarkable that though the quantity of electric current which flows any day or week through liquids or gases is quite insignificant in comparison with that which flows through metals, our views of the nature of conduction through gases or liquids are much more settled and definite than any we possess with respect to metals; it is remarkable, too, that progress in this subject is the outcome of the study of the flow of electricity through gases rather than through liquids, and that it is gases and not liquids which have given us the clue which promises to lead to the solution of the conduction of electricity through metals, which from many points of view is by far the most important case of conduction.

Many physicists have had the idea that the passage of electricity through metals might be analogous to that through liquids, where we have strong evidence that the current is carried by atoms or groups of atoms charged with electricity. Some of these atoms are charged with positive electricity, others with negative, but all help to carry the current, the positively charged ones by moving in the direction of the current, the negatively charged ones in the opposite direction; in the case of liquids the passage of the current is inextricably connected with the movement of atoms through the liquid. A familiar instance of this is the ordinary electrolytic bath for electroplating. Now, as I have said, some physicists had the idea that electric currents get through metals by the motion of charged atoms in much the same way as they get through liquid, and they naturally made experiments to see if they could detect any transport of metal which is so marked a feature when currents pass through liquids. Speaking generally, these experiments were of two types. In one type the current was sent through a wire made of an alloy of two metals. The proportion of the two metals in the wire before a current was passed through it was determined with great care. A powerful current was then sent through the wire for a long time, and the wire was again analysed, samples being cut from the end at which the current went in and also from the end at which it went out. If there had been any transport of atoms by the current, the composition of the end where the current entered would be different from that of the end where it left. The experiment showed that no difference could be detected, even when enough current had passed through the wire to carry all the metal in the wire from one electrode to the other if the metal had been in a salt dissolved in an electrolytic bath. The other type of experiment was to put plates of two metals, say gold and lead, together, taking care that there was good contact, and then send a strong current across the junction for a considerable time, and at the end of that time see if any lead had been carried into the gold or any gold into the lead. Not the slightest trace of any such transport could be detected. These experiments showed that the electricity was not carried through metals by charges on atoms or any combination of atoms, and as at that time no other carriers of electricity were known, the difficulties in the way of supposing that the current was carried by moving electric charges seemed insuperable. Relief, however, came from the study of the passage of electricity through gases, which showed that there were other carriers of electricity besides atoms.

These carriers, which are called corpuscles or electrons, are exceedingly small compared with the smallest atom known, that of hydrogen. They form a part of every kind of atom, and, however different the atoms from which the electrons come may be, the electrons themselves are invariable. There is only one kind of electron, and this has a mass of $\frac{1}{1700}$ that of a hydrogen atom, and carries a constant charge of *negative* electricity. The discovery of the corpuscle or electron put an entirely different com-

[1] Lecture delivered before the Institute of Metals by Sir J. J. Thomson, O.M., F.R.S.

plexion on the question of metallic conduction, for, if the carriers of the current are electrons and not atoms, if the conduction is electronic and not electrolytic, there need be no transport of the atoms of the metal by the current; if the electrons, which are of the same kind whatever the metal, can move, there is no need for the atoms to do so. Thus, if metals contain electrons which can move freely under an electric force, they would certainly conduct electricity, and thus physicists investigated the consequences of supposing that metallic conduction arose in this way. It is easy to get direct evidence of the existence of electrons in metals, for when the metals are raised to a very high temperature so as to be incandescent, as in the case of the filaments of electric lamps, large quantities of electrons are given off, and though the emission is greatly affected by the presence of gas in the metal, the behaviour of Coolidge tubes, in which a tungsten filament continues to give out electrons for months in the highest vacuum that can be obtained, shows that the presence of gas is not absolutely essential for the emission of electrons.

Let us, then, see what the electrical properties of a metal would be if it had free electrons disseminated through it, the metal acting as a cage for the electrons, which can move between the atoms of the metal. The assemblage of electrons is supposed to have the properties of a gas, and to be in temperature equilibrium with the metal—in other words, the electron temperature is the same as that of the metal. In gases the average kinetic energy of the molecules depends only upon the temperature, and not upon the nature of the gas; thus the average kinetic energy of the electrons will be the same as that of the molecules of air at the same temperature. As the mass of an electron is exceedingly small compared with that of a molecule of air, if the average kinetic energy of the two is to be the same, the average velocity of the electron must be very much greater than that of the air molecule. At 0° C. the velocity of the electron works out at 10^7 centimetres per second, or, roughly, sixty miles per second. If there is no electric force acting on the metal, then, though the motion of the electrons produces movement of electricity, there is no flow of electricity through the metal, for whatever is the number of electrons moving in any direction, there are just as many moving in the opposite. If, however, an external electric force is applied to the metal, the electrons under this force will, since they are negatively electrified, drift in the opposite direction to the force. This will cause a current, proportional to the number of electrons which pass in one second across a unit area drawn at right angles to the force, to flow through the metal. Thus, if n is the number of electrons per unit volume, e the charge on an electron, w the velocity of the drift,

$$new = \text{current through unit area.}$$

The velocity of drift w is proportional to the electric force X. Let it equal kX, then the current is kneX, and kne is the specific conductivity of the metal. Thus the presence of these electrons will make the metal a conductor of electricity. It will also give to the metal specific powers for the conduction of heat. For if different parts of the metal are at different temperatures, the electrons in those parts will also be at different temperatures, and thus the metal will be in the condition of being filled with a gas which is hotter at one place than it is at another. Confining our attention to the gas, heat will flow from the hot parts to the cold, and, as the kinetic theory of gases shows, the conductivity for heat of the gas will be proportional to nk. This is proportional to the specific conductivity of the metal for electricity. Thus that part of the conductivity for heat of the metal which arises from the presence of the electrons will be proportional to the electrical conductivity, and if the greater part of the heat conductivity is due to the presence of electrons, the thermal conductivity should bear a constant ratio to the electrical conductivity. Thus good conductors of heat should be good conductors of electricity; in fact, the two conductivities should bear a constant ratio to each other. Now, at any rate at ordinary temperatures, the constancy of this ratio is very remarkable. I will illustrate this in two ways: (1) by a table, and (2) by a diagram. The table, which is due to Jaeger and Diesselhorst, is as follows:—

Material	Thermal Conductivity / Electrical Conductivity At 18° C.	Temperature coefficient of this ratio. Per cent.
Copper, commercial	$6{\cdot}76\times10^{10}$	—
Copper (1), pure	$6{\cdot}65\times10^{10}$	0·39
Copper (2), pure	$6{\cdot}71\times10^{10}$	0·39
Silver pure	$6{\cdot}86\times10^{10}$	0·37
Gold (1)	$7{\cdot}27\times10^{10}$	0·36
Gold (2), pure	$7{\cdot}09\times10^{10}$	0·37
Nickel	$6{\cdot}99\times10^{10}$	0·39
Zinc (1)	$7{\cdot}05\times10^{10}$	0·38
Zinc (2), pure	$6{\cdot}72\times10^{10}$	0·38
Cadmium, pure	$7{\cdot}06\times10^{10}$	0·37
Lead, pure	$7{\cdot}15\times10^{10}$	0·40
Tin, pure	$7{\cdot}35\times10^{10}$	0·34
Aluminium	$6{\cdot}36\times10^{10}$	0·43
Platinum (1)	$7{\cdot}76\times10^{10}$	—
Platinum (2), pure	$7{\cdot}53\times10^{10}$	0·46
Palladium	$7{\cdot}54\times10^{10}$	0·46
Iron (1)	$8{\cdot}02\times10^{10}$	0·43
Iron (2)	$8{\cdot}38\times10^{10}$	0·44
Steel	$9{\cdot}03\times10^{10}$	0·35
Bismuth	$9{\cdot}64\times10^{10}$	0·15
Constantan (60 Cu, 40 Ni)	$11{\cdot}06\times10^{10}$	0·23
Manganine (84 Cu, 14 Ni, 12 Mn)	$9{\cdot}14\times10^{10}$	0·27

If we suppose that all the heat is carried by the electrons, the kinetic theory of gases (on certain assumptions as to the nature of the collisions between two electrons and an electron and an atom) leads to the equation:—

$$\frac{\text{Thermal conductivity}}{\text{Electrical conductivity}} = \frac{4}{3}\frac{a^2\theta}{e^2}.$$

Where e is the charge on an electron, θ the absolute temperature, and $a\theta$ the average kinetic energy of a molecule of a gas at this temperature, all these quantities are known. Substituting their values in the equation, we find that the ratio of the conductivities is $6{\cdot}3\times10^{10}$ and the temperature coefficient 0·366 per cent. The close agreement between these numbers and those determined by experiment is very remarkable.

Fig. 1 is a diagram which represents the electrical and thermal conductivities of alloys of bismuth and lead in varying proportions. It will be noticed that any sudden change in one conductivity is accompanied by a corresponding change in the other.

These results point to the conclusion that in metals not only the whole of the current but the greater part of the heat is carried by the electrons. This does not imply that the electrons are the only agents by which heat can be conducted, but merely that in metals most of the heat is carried in this way. In insulators such as glass, though the thermal conductivity is small, its ratio to electrical conductivity is very much greater than for metals.

The conception of free electrons in metals affords a ready explanation of many of their electrical properties. Let us consider for a moment what will happen if we put two different metals, A and B, into contact. Both A and B contain electrons, but one, A say, has more per unit volume than the other; thus the pressure of the electrons in A is greater than that of the electrons in B. Thus, when the two metals are put in contact, electrons will rush out of A into B. As these electrons carry negative electricity with them, B will be negatively electrified, and its electrification will increase until the repulsion it exerts on the electrons in A is sufficient to balance the excess of pressure, and to prevent any more electrons from passing from A to B. Those that do pass, however, will establish a difference of potential between A and B, and in this way we have a simple explanation of the difference of potential arising from the contact of metals.

Again, when an electric current passes through an unequally heated metal, electrons will drift from places of high to places of low potential, and carry heat with them; thus the passage of a current of electricity through an unequally heated conductor will alter the flow of heat. This is a well-known effect; it was

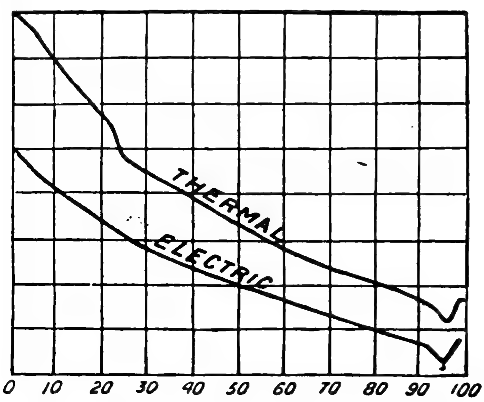

FIG. 1.—Conductivities of alloys of bismuth and lead.

discovered by Lord Kelvin, and is known as the Thomson effect. Closely connected with this is the effect produced when we suddenly heat one part of a conductor. This will raise the temperature of the electrons in that part and increase their pressure; they will overflow into other parts of the conductor, and the charges they carry will produce electromotive forces arising from unequal heatings. These, too, are a well-known feature of metallic conduction.

We thus see that the characteristic features of metallic conduction can be explained in a general way by the theory that free electrons are dispersed through the metal. We have not, however, considered as yet how many of these free electrons would be required to produce conductivity as great as that of metals. This is a very important point, for these free electrons will produce other effects besides electrical ones. While their presence endows the metal with electrical conductivity, the property we wish to explain, it also endows it with other properties which have to be explained away. We have to satisfy ourselves that the number of electrons required for metallic conduction is so small that the undesirable effects are negligible. Let us consider for a moment the nature of some of these effects. We have supposed the electrons to be in temperature equilibrium with the metal, so that when we heat the metal we also heat the electrons. Now, to raise the temperature of a number of electrons requires just as much energy as to raise that of the same number of molecules of air—the specific heat of electrons is the same as that of the same number of air molecules. And it might, and in certain cases we shall see that it does, happen that so many electrons were required to explain the metallic conduction that their specific heat would be considerably greater than the observed specific heat of the metal. This is even the case when we suppose that the increase in the temperature does not increase the number of the electrons. The production of free atoms from the metal is, however, a case of dissociation, a neutral atom of the metal dissociating into an electron and a positively charged atom. The dissociation might be expected to increase with temperature, so that when we raise the temperature we have to supply not merely the work required to raise the temperature of the electrons already present, but also the work required to detach fresh electrons, and this additional work will increase the apparent specific heat; thus the effective specific heat of a number of electrons may be considerably greater than that of the same number of molecules of air.

Another point, too, has to be taken into consideration: every electron present in the metal requires the presence of one positively electrified atom. If there are as many electrons as atoms, then, supposing each atom carries only one charge, every one of the metallic atoms must be charged with positive electricity; if there were six times as many electrons as atoms, each atom would have on the average to be charged with six units of electricity. So that any great excess of electrons over atoms is only possible if the atoms can receive positive charges which are many multiples of one unit. Now there are strong reasons for thinking that the number of positive charges on an atom, or, what is the same thing, the number of electrons which can be taken out of it, cannot, at any rate in the circumstances of the atoms in the metal, be any very large multiple of the atomic unit of electricity. It is true that we have reason to believe that there are in an atom a number of electrons equal to half the atomic weight, but the great majority of those are deeply seated and require the expenditure of large amounts of energy before they can be liberated. The number of electrons which can be detached from an atom of a metal in normal circumstances is probably quite small; and it would be a grave difficulty if, in order to explain metallic conductivity, we had to assume that the number of electrons was largely in excess of the number of atoms.

Let us now proceed to calculate the number of electrons required to explain metallic conduction. We have seen that the specific conductivity of a metal is equal to nke, where n is the number of electrons per unit volume, k the drift of the electrons under unit electric force (k is called the mobility of the electron), and e the charge on the electron. We know the specific conductivity, and e, and hence we can determine nk. I will, for the sake of definiteness, take the case of silver at 0° C. For this metal, $nk = 3{\cdot}9 \times 10^{16}$. The specific resistance gives us only the value of the product nk. To determine n we must, from other sources, form an estimate of k. I will consider two methods: the first, an indirect one based on values of k derived from experiments made on gases. The drift k, which can be compared with the terminal velocity acquired by a weight falling through a viscous liquid, depends upon the effects of the collisions which the electrons make with the atoms of the metal through which they are moving. Maxwell proved that where a particle drifts through a gas with a velocity u, it loses momentum at the rate βu; β is a coefficient directly proportional to the number of molecules per unit volume of the gas through which the

particle is drifting, and depends also upon the force which a molecule exerts on a particle when it comes near it. When the particle is under the action of an electric force X, the momentum communicated to it by the force per second is Xe; when it settles down to a steady state, the gain in momentum from the force must equal the loss from the impacts, so that $\beta u = Xe$ or $u = Xe/\beta$, and k must be equal to e/β. Let us try to estimate the value of k for metals, from the measurements which have been made of the drift of electrons in circumstances where it can be measured. In conduction through flames the negative electricity is carried by electrons, and at a temperature of 2000° C. the speed of the electrons under a force of a volt per centimetre is estimated at 10,000 centimetres per second. This would make the speed of an electron through air at normal pressure at 0° C. under the same electric force about 3300 centimetres per second. Now, in the air there are $2{\cdot}75 \times 10^{19}$ molecules per cubic centimetre, while in a cubic centimetre of silver there are about 6×10^{22} atoms of silver, about 2200 times the number of air molecules, hence we should expect the velocity of an electron in silver under a volt per centimetre would be about 3300/2200 or 1·5 centimetre per second. k is the velocity for unit force which is $1/10^8$ of a volt per centimetre, so that k should be about $1{\cdot}5 \times 10^{-8}$, and since $nk = 3{\cdot}9 \times 10^{16}$, n would be $2{\cdot}6 \times 10^{24}$. This is about forty times the number of silver atoms, so that the silver atoms would have on the average a charge of forty units. This number of electrons would exert a pressure of 100,000 atmospheres, and their specific heat in unit mass of silver would be many times the actual specific heat of silver.

We can also estimate the number of electrons required on this theory by considering the resistance of the metal under periodic instead of steady electric forces. If the electric force is represented by $X \cos pt$, then we can show that if u is the velocity of drift, m the mass of an electron,

$$m\frac{du}{dt} + \beta u = Xe \cos pt,$$

the solution of which is

$$u = \frac{Xe \cos (pt + \theta)}{\beta \sqrt{1 + m^2p^2/\beta^2}}.$$

Thus the effective resistance under alternating currents is greater than that under steady currents in the proportion of $\{1 + (m^2p^2/\beta^2)\}^{\frac{1}{2}}$ to 1. Now one very interesting case of alternating electric forces is that of a wave of light. Rubens has investigated the resistance of metals under the electric forces which occur in light of various wave-lengths. He finds that when the wave-length is greater than 2×10^{-3} centimetres the resistance is indistinguishable from that for steady currents, and when the wave-length is 4×10^{-4} centimetres the resistance is only 20 per cent. greater. It is the second of these results which we shall use to calculate β. p for a wave-length of 4×10^{-4} is $1{\cdot}5 \times \pi 10^{14}$, and if the resistance is increased by 20 per cent. $m^2p^2/\beta^2 = 2/5$, or $mp/\beta = 2/\pi$, approximately; thus $\beta = 7{\cdot}5 \times 10^{14} \times m$; and since $k = e/\beta$, and $e/m = 1{\cdot}7 \times 10^7$, $k = 2{\cdot}2 \times 10^{-8}$. As $nk = 3{\cdot}9 \times 10^{16}$, $n = 1{\cdot}8 \times 10^{24}$. This is not greatly different from the value we got by the preceding method, and leads again to the conclusion that to explain an electrical conductivity as large as that of silver requires a number of electrons so great that each atom of silver would have on an average to lose 20 or 30 electrons, and the specific heat of these would be far greater than the actual specific heat of silver.

A great deal of work has been done in recent years on the specific heats of metals, but, so far as I know, no effect has been found which can be traced to electrons, nor is there any trace of energy being absorbed in dissociating the atoms of the metal into electrons and positively charged atoms.

Variation of Electrical Resistance with Temperature.

The fact that to a considerable degree of approximation the electrical resistance of all pure metals is at all but the lowest temperatures proportional to the absolute temperature, is a result of such generality that we should expect it to be a direct consequence of any adequate theory of electrical resistance. On the theory that the conductivity is due to free electrons, this result, so far from being an obvious consequence of the theory, is very difficult to reconcile with it. The conductivity of the metal is, as we have seen, the product of two factors, n the number of free electrons, and k the mobility of an electron, and since the conductivity is approximately inversely proportional to the absolute temperature, nk must be very much greater at low temperatures than at high. Consider the factors separately, we certainly should not *a priori* expect n to be larger at low temperatures than at high ones, for we regard the free ions as due to the dissociation of the atoms of the metal, and thus to have much the same connection with temperature as the products of dissociation in such a case as the dissociation of molecules of iodine. In such cases, however, n is proportional to $e^{-\frac{w}{RT}}$, where T is the absolute temperature, R the gas constant, and w proportional to the work required to dissociate the system. Now this factor, instead of increasing as the temperature diminishes, decreases, and does so very rapidly indeed, when RT is small compared with w. If, then, the product nk is much greater at low temperatures than at higher ones, the increase must be due to the factor k—that is, the mobility of the system must increase very rapidly as the temperature diminishes. Now the theory of the motion of an electron through a number of centres of force, each of which acts on the electron with a force inversely proportional to the p^{th} power of the distance, leads to the result that k is proportional to $\theta^{\frac{2}{p-1} - \frac{1}{2}}/m$, where m is the number of attracting centres per unit volume and θ the temperature. The product nk varies approximately as θ^{-1}, and since n diminishes as θ diminishes, k must increase more rapidly as θ diminishes than θ^{-1}; for this to be the case p must be less than one, an extremely improbable result. If we suppose that the force exerted by a positively charged atom on the negative electron is so much greater than that exerted by a charged one that it is the collisions with the charged atoms that determine the mobility, $m = n$ and $p = 2$, then nk varies $\theta^{\frac{3}{2}}$—*i.e.* the conductivity should increase with the temperature instead of diminishing.

The very remarkable results got within the last few years by Kamerlingh Onnes, in his experiments on the electrical resistance of metals at very low temperatures, seem to me to tell against the theory that the conduction is due to free electrons, while they receive a simple explanation on the theory which I am about to suggest. Kamerlingh Onnes finds that the resistance of some pure metals, such as mercury or lead at the temperature of liquid helium or thereabouts, becomes too small to be measured, and is certainly less than one-thousandth-millionth of its value at 0° C., whereas, if it diminished in proportion to the temperature it would only be diminished by one-seventieth. He has found, too, the very remarkable result that a current once started by moving a magnet in the neighbourhood of a lead ring at this temperature, lasted with little diminution more than two hours

without the application of any further electromotive force, and he estimates that it would take four days to fall to half its value; we have here a somewhat close approach to a perfect conductor. We saw that much smaller increases in conductivity at low temperatures were a difficulty in the way of the free electron theory, the enormous increases in the conductivity discovered by Kamerlingh Onnes make these difficulties much more formidable. These increases, however, admit of a very simple explanation on a theory which I suggested some time ago—in fact, the main features of the theory are the same as one I gave in my "Applications of Dynamics to Physics and Chemistry, 1888," except that as at that time the electron had not been discovered, I had to suppose that the electricity was carried by atoms; this involved the transport of the metal by the current, a difficulty which disappeared on the discovery of the electron.

Perhaps the clearest way of introducing the theory is to direct your attention to a theory with which many of you are doubtless familiar, that of the magnetisation of iron, which has many analogies with our theory. This theory of magnetisation supposes that a piece of iron is a collection of an immense number of little magnets, called molecular magnets; when the iron is not magnetised these molecular magnets are all higgledy-piggledy, so that they completely neutralise each other's effects, and the iron shows no sign of magnetisation. When, however, the iron is acted on by a magnetic force, the force acting on the magnet tends to make them swing round, so as to point in the direction of the force; the result is that more point in this direction than in any other. As some order is brought into their arrangement, they no longer neutralise each other, and the iron as a whole behaves like a magnet. The intensity of magnetisation will be measured by the excess of the number of those which point in the direction of the magnetic force over those which point in any other directions. Now, when the magnetic force acts on the iron, why do not all the magnets swing round and point in the direction of the force? It is because there are other causes at work tending to knock them out of line as fast as the magnetic force pulls them back. One of these causes is the knocking about they get in consequence of the movement of the molecules arising from their temperature. This is more violent at high temperatures than at low, and so more will be pulled into line by the same force at low temperatures than they would at high. There seems to be evidence that this is the cause that is most efficacious in preventing the complete set of the atoms; and Langevin has shown that, neglecting other effects and supposing the collisions are like those in a gas, the intensity of magnetisation can be represented by the expression

$$I = NM\left\{\frac{\epsilon^x+\epsilon^{-x}}{\epsilon^x-\epsilon^{-x}} - \frac{1}{x}\right\}$$

where

$$x = \frac{H^1 M}{RT}.$$

N is the number of magnets per unit volume, M the moment of a little magnet, T the absolute temperature, R the gas constant, and H^1 the force acting on a little magnet. H^1 will consist of two parts, one the external magnetic force, the other due to the action of the magnets in its neighbourhood. This will be proportional to I; let it equal kI.

$$x = (H + kI)\frac{M}{RT}.$$

The graph representing the relation between x and I is thus a straight line, and to find the value of I corresponding to any value of H, we draw this line and find where it intersects the curve **U**, the equation of which is

$$I = NM\left(\frac{\epsilon^x+\epsilon^{-x}}{\epsilon^x-\epsilon^{-x}} - \frac{1}{x}\right)$$

and the graph of which is represented in Fig. 2.

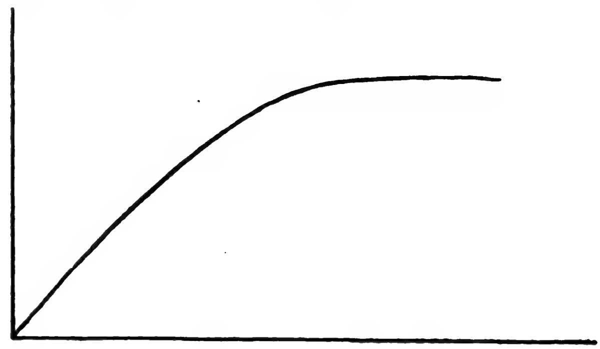

FIG. 2.

Let us now turn to the problem of the metal. We will suppose that each atom of the metal contains an electrical dipole—the electrical analogue of a molecular magnet. The molecular magnet consists of equal and opposite magnetic poles separated by a short distance. The electrical dipole consists of equal and opposite electrical charges at a short distance apart, the negative charge being an electron. These dipoles if acted on by an electrical force will set themselves along the lines of electric force, in the same fashion as the magnets along the lines of magnetic force; the result will be the same as if a certain fraction pointed in the direction of the electric force, while the remainder pointed indifferently in all directions. We thus shall have in the substance a number of chains of atoms arranged as in Fig. 3. So far there is nothing in the behaviour of these atoms which depends on the difference between a non-metal and a metal. The existence of these chains will produce what is called specific inductive capacity in the medium. But you will see that the doublets in the atoms will produce intense electric forces in their neighbourhood, and these forces will tend to drag the electrons out of one atom into the other. Now, on this theory, the difference between an insulator and a metal is that the electrons in an atom of an insulator are able to resist this pull and remain within the atom. In a metal, on the other hand, the electrons are much more easily detached, and yield to the pull, and electrons pass from one atom to another along the chain. Let us suppose that in consequence of this action p electrons pass along the

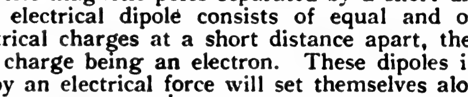

FIG. 3.

chain per second. The force which drags the electrons out is due to the pull exerted by the atoms in its neighbourhood, and so does not depend on the magnitude of the electric force. Since p electrons pass along each chain per second, the quantity of electricity which passes through unit area per second is Npe, where N is the number of chains through unit area, hence

$$i = Npe.$$

Now, if I is the number of doublets per unit volume which point in the direction of the electric force, and

d the distance between the centres of two doublets, the number of doublets in unit length of a chain $= 1/d$; hence $N/d = I$, or $i = Idpe$.

Now we have seen that

$$I = Nm\left(\frac{\epsilon^x + \epsilon^{-x}}{\epsilon^x + \epsilon^x} - \frac{1}{x}\right) = Nm\frac{x}{3} \text{ along the straight part of}$$

the curve when n is smaller.

Also

$$x = \frac{m(X_0 + kI)}{R\theta}.$$

We determine for I, and therefore i, in terms of X_0, by the graphical method; but it will bring out the main points of the theory if I confine myself to intersections along the straight part of the curve, where

$$I = Nm\frac{x}{3} = \frac{Nm^2}{3}\frac{(X_0 + kI)}{RT}$$

So
$$I = \frac{\frac{Nm^2}{3}X_0 \times \frac{1}{RT}}{1 - \frac{Nm^2k}{3RT}}$$

Or if we take a temperature T_0, such that $\frac{Nm^2}{3RT_0}k = 1$.

$$I = \frac{1}{k}\frac{X_0T_0}{T - T_0}$$

$$i = \frac{1}{k}\frac{X_0T_0dpe}{T - T_0}$$

Thus σ, the specific conductivity of the metal, $= \frac{1}{k}\frac{dpeT_0}{T - T_0}$.

Thus the conductivity becomes infinite, or the resistance vanishes when $T = T_0$. When we take the accurate solution instead of the approximate one, we find that the conductivity, though very great, is not infinite; the curve 1 bends round and meets the straight line, and when the intersection takes place in the curved portion the current no longer follows Ohm's law. We thus see that in the neighbourhood of a certain temperature the resistance diminishes with great rapidity, a point brought into great prominence by Kamerlingh Onnes.

If we compare the external force with the force kI, due to the atoms, we see from these equations that $kI/X_0 = T_0(T - T_0)$; so that near the critical temperature the force due to these atoms is enormously greater than the external force, so that the chains are held mainly by the forces between the atoms, and we can easily see by the graphical method of solution that when the temperature is below the critical temperature we can withdraw the electric force and still leave the greater part of the chains intact.

SUPER-CONDUCTIVITY.

Let us now consider what happens when the temperature is diminished; the slope of the line (1) continually decreases and the intersection of this line with the curve gets further and further away from the origin; when the intersection comes on a part of the curve at an appreciable distance from the tangent at the origin, Ohm's law will no longer hold. Suppose that the slope of the line (1) has fallen so that, as in Fig. 2, it is less than that of the tangent at the origin to the curve $I = NMF(x)$, and after the application of a force X_0 suppose the force is gradually removed, the value of I corresponding to the diminished force will be got by drawing parallels to PQ continually getting nearer to the origin, and its value when the force has been entirely removed by drawing a parallel through the origin itself. We see from the figure that in this case the line through the origin will intersect the curve again at S, showing that I retains the finite value SN after the electric force has disappeared. From the point of view of this paper, however, the part played by the electric force in metallic conduction is to polarise the metal, *i.e.*, to form chains: when once these are formed the electricity is transmitted along them by the forces exerted by the atoms on the electrons in their neighbours. Thus if the polarisation remains after the electric force is removed the current will remain too, just as it did in Kamerlingh Onnes' experiment with the lead ring. The argument is similar to that by which Weiss explained the existence of permanent magnetism below a critical temperature.

The remarkable results obtained by Kamerlingh Onnes only occur at the temperature of liquid helium; at the temperature of liquid hydrogen the metals show no sign of super-conductivity, the discovery of which is thus a result of being able to lower the lowest available temperature a few degrees; it is a very striking instance of the truth of Browning's line:

The little more and how much it is.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The General Board of Studies, in its annual report to the Senate, reviews the work done and progress made in the experimental departments of the University during the academic year, 1914–15. A large proportion of the scientific staff and some forty of the laboratory assistants are absent on military service; this, together with the enlistment of most of the students of military age, has led to a diminution of the usual output of original experimental investigation. A large amount of experimental work has been done gratuitously for a number of Government departments in connection with problems arising out of the war, and certain of the laboratories have been able to offer such facilities to professors of Belgian universities as have enabled them to continue the instruction of their pupils in this country.

The School of Forestry has been greatly assisted by Lord Cowdray, who has offered ample facilities for the practical study of forestry in his woodlands, which cover some seven square miles of country in Sussex. The research hospital is being used for the treatment of wounded officers under the control of the Army Council, and some 300 patients have been already received. The pathological museum has been enriched by a collection of specimens illustrating the effect of gunshot and other wounds on the bones and soft tissues, the material having been provided by the 1st Eastern General Hospital.

THE annual meetings of the Geographical Association will be held on January 6 and 7, at University College, London. On the morning of January 6, the presidential address will be delivered by Mr. H. J. Mackinder, and afterwards a discussion on "The First Steps in Geography Teaching" will be opened by Miss E. G. R. Taylor. In the afternoon Dr. Marion Newbigin will lecture on "The Geographical Study of Rivers," and the lecture will be fellowed by a discussion on "The Use of Home-made Apparatus," which will be opened by Mr. E. J. Orford. On the morning of January 7 a joint meeting of the Geographical and Historical Associations will be held, to discuss "The Relations of Geographical and Historical Teaching in Schools." Mr. H. J. Mackinder and Prof. Ramsay Muir will open the discussion.

PRACTICALLY the whole of our engineering colleges have now overcome the early difficulties and opposition which attended the starting of making munitions and otherwise rendering assistance in the present

emergency, and are now showing a production of gauges, gun parts, etc., which many engineers unacquainted with the capabilities of college workshops and staffs have found difficult to credit. Colleges not making munitions are training workers for the new munition factories, and many have undertaken researches of various kinds. Some information regarding the work in progress will be found in a paper by Dr. Walmsley and Mr. Larard, read at the Institution of Mechanical Engineers on December 17. It is to be hoped that the closer connection which exists at the present time between colleges and engineering works will not be broken when the war is over. Each side has much to learn from the other, and it promises well for the future that old prejudices on both sides are fast disappearing.

IT is announced in the issue of *Science* for December 10 that Mrs. Russell Sage has given Syracuse University a fund to build a college of agriculture as a memorial to her father. The building is to cost several hundred thousand dollars, the exact sum to be decided later. Our contemporary also states that a new building will be constructed for the University of Illinois Medical School in Chicago for the clinical courses. The initial cost is to be about 20,000*l.*, which will pay for one wing. This will be added to later as the demand for room increases. From the same source we learn that the trustees of Delaware College have made plans for the expenditure of a gift of 100,000*l.* to the college by an unnamed donor. A report submitted by the chairman of the Plans and Development Committee, which has been approved by the board, shows that 50,000*l.* will be used for a science hall to house the agricultural and chemical departments, 15,000*l.* to remodel the old dormitory building and turn it into a commons for the students, and 40,000*l.* will be set aside for maintenance.

AMONG the resolutions passed by the Headmasters Conference last week was one moved by Mr. A. L. Francis, headmaster of Blundell's School, Tiverton, "That in the opinion of this conference very grave loss to the country is caused by the employment of young students of exceptional mathematical and scientific ability as subalterns in Line battalions." Several important questions are raised by this resolution, but the chief point put forward by Mr. Francis was that the country should not permit itself to be deprived of its most ingenious and inventive brains in the grim struggles of the battlefield. "The place for the young man who has a special gift for science, mathematics, or mechanics is in the laboratory." Everyone will agree with this in principle, but the practical difficulty in deciding what students are sufficiently endowed with a "special gift" to be husbanded for national work in science and invention is another matter. The young students to whom Mr. Francis seemed to refer were those of Public School age, but it may be doubted whether at such an early stage it is possible to distinguish the few original minds which are destined to create new knowledge. Success in examinations certainly does not provide a true standard by which this genius for productiveness in science and invention may be measured. What we all deplore, and think should be avoided, is the sacrifice of men like Capt. J. W. Jenkinson and Lieut. Moseley, who had shown exceptional ability as original investigators. Apparently the Headmasters Conference does not object to the young students embraced by the resolution becoming subalterns in corps of engineers and artillery, where there are opportunities of applying a knowledge of science and mathematics, or even in the guards or the cavalry, where there may be no such need. Hundreds of able students of mathematics and science from university colleges and technical schools are at present serving as privates and non-commissioned officers in the Army, and the rank offered by the War Office to exceptional men in such subjects as chemistry and mining is not usually that of a subaltern but of a corporal.

THE annual report of the Royal Technical College, Glasgow, for the session 1914–15, has reached us. The "Roll of Members, Students, and Past Students on the King's Service" forms an appendix of a hundred pages. The roll comprises eight members of the governing body and of committees, 37 members of the staff, 1152 students of 1914 and 1915, and 622 students of previous sessions. These are serving in the following capacities:—Officers, 490; non-commissioned officers, 351; men, 966; nurse, 1; and on special service, 11. The appointment of 114 naval officers from the School of Navigation is specially noteworthy. The report records the deaths of ninety-one whose names appear on the roll. The reduction in the normal work of the college is indicated by the following comparative table of the number of students who enrolled:—

	Day students	Evening students	Total individuals
1914–15	445	2583	3028
1913–14	669	4342	5011

These enrolments necessarily include the large number of students who offered themselves during the session for active service, or who received appointments under firms manufacturing munitions. Many former members of the staff and students of the department of chemistry are now engaged in this work, and this department has made a contribution of about 150 men to the corps of chemists attached to the Royal Engineers. There are usually about 150 day students at work in the chemical laboratory during the session, but in the last week this number had dwindled to four, while of ten assistants on the staff only two were left. The plans for the increase of the new endowment fund initiated to extend the facilities available for higher studies and for research work have necessarily been postponed, but a grant of 5200*l.* from the Bellahouston Trustees towards this object is acknowledged in the report.

SOCIETIES AND ACADEMIES.

LONDON.

Geological Society, December 1.—Dr. A. Smith Woodward, president, in the chair.—Dr. J. W. **Evans**: Petrological methods. The different methods of obtaining the directions-image ("interference figures") of a small mineral in a rock-slice, unaffected by the light from neighbouring minerals, were discussed. The author prefers the use of a diaphragm in the focus of the eyepiece, in conjunction with a Becke lens; he also described the inferences that might be drawn from the form, position, and movement on the rotation of the stage of the isogyres (dark bars or bushes) in the directions-images, both of chance sections and of those cut parallel to planes of optical symmetry or at right-angles to optical axes. He showed how the character or sign of the crystal and its approximate optic axial angle might be determined.

Linnean Society, December 16.—Prof. E. B. Poulton, president, in the chair.—E. S. **Goodrich**: The reproduction of Protodrilus. The author criticised the account given by Prof. U. Pierantoni, according to whom there are in most species of the genus male and hermaphrodite individuals. Dr. Orton having recently discovered ***Protodrilus flavocapitatus*** at Plymouth, the author has been able to study large numbers at the Marine Biological Laboratory. The appar-

ent males and females are about equal in size and number; but in ripe females spermatozoa can often be seen, and many of the ova are fertilised. Mr. Goodrich brought forward evidence that these spermatozoa are derived from the males, are not developed in the females, and that their presence is due to normal internal cross fertilisation between the sexes.—Miss Marietta **Pallis**: The structure and history of "Plav," the floating fen of the delta of the Danube. Plav is a Russian word: it signifies the floating thing or floating stuff, and is the name given by the fishermen of the delta of the Danube to a floating raft of vegetation built up almost entirely of living reed, *Phragmites communis*, Trin., *β. flavescens*, Gren. and Godr., and earth. The variation in length of the aerial portion of the reed-shoots is so striking (they vary from about 4 ft. to about 17 ft.), that it suggests the presence of different varieties of reed. Evidence is given that this variation is not specific or due to the factors of the environment, but is inherent in the reed. The different sizes of reed-shoots are held to be different branches of a definite and complicated reed-system, the first and final branches of which do not co-exist.—T. A. **Dymes**: The seed-mass and dispersal of *Helleborus foetidus*, Linn. The seeds of *H. foetidus*, L., are remarkable in being shed from the follicle in a single mass, bound more or less tightly together by a thick, white ventral strip of oleaginous tissue. Owing to the contrast of the shining elaiosome with the almost black seeds, the mass as a whole bears, at a short distance, a deceptive resemblance to the larva of a beetle. Observations were made, over two consecutive nights, on the work of the snails, which disintegrate the mass by devouring the elaiosome, thus reducing it eventually to single seeds. Experiments were also made with a view of establishing the possibility of molluscan dispersal of single seeds over a short distance. Observations in nature, and on captive *Helix aspersa*, point to the conclusion that the elaiosome offers an attraction as a molluscan dainty in the way of food. Experiments in the open do not support the idea of the larval resemblance being an adaptation to ornithochory, or that there is any regular dispersal by the birds of the neighbourhood. Observations and experiments with the ants, *Donisthorpea nigra* and *Myrmica laevinodis*, prove that they carry off whole masses, fragments, and single seeds, and take them into the nest. On the other hand, their behaviour does not favour the suggestion that the larval "mimicry" is operative, so far as they are concerned. The claim to myrmecochory is not a valid one. So far as the ants are concerned, neither the larval resemblance nor the massing brings to the species any advantage which it would not possess if the seeds were shed singly, as is usually, if not universally, the case with those that are adapted to these insects. The larval resemblance, which cannot be denied, suggests an adaptation to some still unrecognised agent or agents, and observations at the distributional headquarters of the species are much to be desired, in order to clear up the mystery of the mass.

MANCHESTER.

Literary and Philosophical Society, November 30.—Prof. S. J. Hickson, president, in the chair.—Prof. G. Elliot **Smith**: Further notes on pre-Columbian representations of the elephant in America. An amplification of the letter published in NATURE of November 25 (p. 340). Further examples of representations of the elephant were shown; and attention was directed to the fact that the Hindu god Indra, who was associated with the elephant, killed Vritra, who kept the rain in the clouds, just as the Central American elephant-headed god stood upon the head of the serpent, who prevented the rain from reaching the earth.—T. A. **Coward**: A change in the habits of the black-headed gull. Owing to the remarkable increase in its numbers since the Wild Birds' Protection Act of 1880, this gull has extended its range inland, and it is now an inland as well as a shore bird. This increase, in north Cheshire, has resulted in a noticeable change of habit, secondary to the change mentioned above, for within the last few years the bird has been roosting nightly on the waters of Rostherne Mere during autumn, winter, and early spring. Normally, the roosting and feeding hours of a bird which feeds upon the coast are regulated by the tides, but these Cheshire birds retire to roost like any other diurnal bird, about sundown. The area which these regular diurnal feeding and nocturnal sleeping black-heads frequent is contiguous to an area where others of the same species feed and sleep according to the constantly changing hours of the tide in the neighbouring Mersey estuary.

DUBLIN.

Royal Irish Academy, December 13.—Sir John Ross of Bladensburg, vice-president, in the chair.—H. **Ryan** and J. **Algar**: Studies in the diflavone group. III.—Derivatives of dicoumaranone and of diflavanone. Dianisylidenediacetoresorcinol, which was prepared by condensing anisaldehyde with diacetoresorcinol, was converted into its diacetatetetrabromide. Alcoholic potash converted the latter compound into dianisylidene-dicoumaranone, instead of forming, as might be expected, di-*p*-methoxydiflavone. In the presence of alcoholic hydrochloric acid dianisylidenediaceto-resorcinol interacted with anisaldehyde to form anisylidene-2-*p*-methoxycinnamoyl-3-hydroxy-4'-methoxyflavanone, and also dianisylidene-4:4'-dimethoxydiflavanone.—H. **Ryan** and M. J. **Walsh**: Studies in the diflavone group. IV.—Diveratrylidenedicoumaranone. By condensing veratric aldehyde with diacetoresorcinol a crystalline solid (diveratrylidenediacetoresorcinol), the constitution of which resembles somewhat that usually attributed to curcumindimethyl ether, was obtained. Unlike curcumin, however, the substance can scarcely be regarded as a mordant dye. It formed a crystalline diacetate, which readily added on bromine, and the product, on warming with potash, gave diveratrylidene-dicoumaranone.—H. **Ryan** and Miss G. **Plunkett**: Unsaturated *β*-diketones. III. By the condensation of veratrylideneacetone with dimethyl oxalate a diketone, 3:4-dimethoxycinnamoylpyruvic methyl ester, was obtained. It formed an *iso*oxazole and a benzeneazo-derivative. Gentle hydrolysis converted it into the corresponding acid. The substances are mordant dyes, and, with mordanted wool, give colours very similar to those got with curcumin, the dimethyl ether of which they probably resemble in constitution.—H. **Ryan** and Miss A. **Devine**: The condensation of aldehydes with ketones. III.—Aldehydes with methyl-ethyl-ketone. *α*-Benzylidenemethyl-ethyl-ketone reacts with benzaldehyde in the presence of aqueous alkali to form a crystalline compound, $C_{18}H_{18}O_2$, which melts at 83–86°. It, as well as *α*-benzylidenemethyl-ethyl-ketone, interacts with benzaldehyde in the presence of alcoholic hydrochloric acid to form a colourless crystalline solid, $C_{25}H_{20}O$, which melts at 156° C. The latter compound may also be got by the action of excess of benzaldehyde on methyl ethyl ketone in the presence of alcoholic hydrochloric acid. *α*-Benzylidenemethyl-ethyl-ketone reacts with anisaldehyde and with piperonal to give the crystalline compounds $C_{27}H_{24}O_3$ and $C_{27}H_{20}O_5$ respectively, and also one molecule of methyl-ethyl-ketone condenses with piperonal to form a crystalline solid which has the formula $C_{24}H_{20}O_7$. The compound $C_{18}H_{18}O_2$ forms an oxime, but the compound $C_{25}H_{20}O$ forms neither an oxime nor a phenylhydrazone. With excess of bromine it gives a dibromide, $C_{25}H_{20}OBr_2$.

PARIS.

Academy of Sciences, December 13.—M. Ed. Perrier in the chair.—G. **Bigourdan**: The forgotten astronomer, Jean de Lignières, and the renaissance of astronomy in Europe. Riccioli ("Astronomia Reformata," 1665), giving the latitudes and longitudes of various stars, reproduced a small catalogue, the author of which was unknown to him, and since called by the name of *Astronomus incognitus*. Reasons are now given showing that this unknown astronomer was Jean de Lignières, a master of the University of Paris. The positions given in this catalogue are for the year 1364.—G. **Humbert**: The approximation of real irrationals.—H. **Douvillé**: The Orbitoids of the Danian and of the Tertiary.—J. **Guillaume**: Observations of the sun made at the Observatory of Lyons during the second quarter of 1915. The observations made on seventy-two days are tabulated, showing the number of spots, their distribution in latitude, and the distribution of the faculæ in latitude.—M. **Mesnager**: The elastic equilibrium of an indefinite plate of uniform thickness, compressed by two equal and opposite forces uniformly distributed along two parallel right lines situated in a plane normal to the bases.—Pierre **Breteau**: The preparation of phosphorescent calcium sulphide. Modifications of Verneuil's method are suggested. The sulphide is first prepared from a mixture of calcium carbonate and sulphur by ignition at a red heat, and this is then impregnated with 1/10,000 of its weight of bismuth. This is again raised to a red heat and allowed to cool slowly.—Mlle. Yvonne **Dehorne**: An Actinostromid of the Cenomanian.—J. **Repelin**: The discovery of deposits of large Pythonomorphs in the Upper Cretacean in the neighbourhood of Jerusalem.—Ph. **Flajolet**: Perturbation of the magnetic meridian at Lyons (Saint-Genis-Laval) during the second quarter of 1915.—A. F. **Legendre**: General considerations on the structural forms of south-western China and the Tibetian borders.—C. **Sauvageau**: The commencements of the development of *Saccorhiza bulbosa*.—Arthur **Compton**: The influence of some meteorological factors on the appearance of cases of cerebrospinal meningitis. The degree of humidity of the atmosphere would appear to be a meteorological factor of great importance in determining the appearance of this disease when the organism is already present in the country.—M. **Weinberg** and P. F. **Séguin**: Researches on gas gangrene. This communication gives the results of the study of a hundred cases of this infection, together with suggestions for a serum treatment.—E. **Vasticar**: The terminations of the acoustic nerve.

BOOKS RECEIVED.

Illustrations of the New Zealand Flora. Edited by T. F. Cheeseman, with the assistance of W. B. Hemsley; the plates drawn by Miss M. Smith. Vol. i. Pp. 8+121 plates and descriptions. Vol. ii. Plates 122–250 and descriptions+pp. xxxiv. (Wellington, N.Z.: J. Mackay.)

Transactions of the English Ceramic Society. Vol. xiv. Session 1914–15. (Stoke-on-Trent: The Society.)

Department of Marine and Fisheries. Report of the Meteorological Service of Canada, Central Office, Toronto, for the Year ended December 31, 1912. Vol. i., Introduction and Parts i.–iii. Pp. xvi+367. Vol. ii., parts iv.–vi. Pp. 368–568. (Ottawa: J. de L. Taché.)

An Introduction to the Principles of Physical Chemistry from the Standpoint of Modern Atomistics and Thermodynamics. By Prof. E. W. Washburn. Pp. xxv+445. (New York: McGraw-Hill Book Company, Inc.; London: Hill Publishing Co., Ltd.) 15s. net.

Hancock's Applied Mechanics for Beginners. Revised and rewritten. By Prof. H. C. Riggs. Pp. xiii+441. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 10s. 6d. net.

The Wheat Industry. By N. A. Bengtson and D. Griffith. Pp. xiii+341. New York: The Macmillan Company; London: Macmillan and Co., Ltd.) 3s. net.

Catalysis and its Industrial Applications. By E. Jobling. Pp. viii+120. (London: J. and A. Churchill.) 2s. 6d. net.

DIARY OF SOCIETIES.

MONDAY, JANUARY 3.

ARISTOTELIAN SOCIETY, at 8.—Time, Space, and Relativity: Prof. A. N. Whitehead

SOCIETY OF CHEMICAL INDUSTRY, at 8.

TUESDAY, JANUARY 4.

RÖNTGEN SOCIETY, at 8.15.—Some Observations upon the Occurrence of Uranium: J. H. Gardiner.

WEDNESDAY, JANUARY 5.

GEOLOGICAL SOCIETY, at 5.30.—The Islay Anticline (Inner Hebrides): E. B. Bailey.

THURSDAY, JANUARY 6.

OPTICAL SOCIETY, at 8.—The Use of a Graticule in Binoculars and Telescopes: S. D. Chalmers.

FRIDAY, JANUARY 7.

GEOLOGISTS' ASSOCIATION, at 7.30.—The Discovery and Excavation of a Large Specimen of *Elephas antiquus* near Chatham: Dr. C. W. Andrews.

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THURSDAY, JANUARY 6, 1916.

MERIT AND REWARD.

On several occasions last year, the Premier and other members of the Government said in the House of Commons that the services rendered by scientific men in connection with war problems had been of high national value. It was acknowledged in the same place last July that practically all the laboratories in the country had been placed at the disposal of the War Office, which had derived great benefit from advice and information received from the Royal Society, the National Physical Laboratory, the universities, and other bodies; and opportunity was then taken to convey the thanks of the Army Council to these scientific and learned bodies.

Recent events have indeed brought men of science into closer relationship with national affairs than ever before, and some attempts have been made to organise their efforts. We give elsewhere in this issue a list of scientific committees appointed by the Government and various societies to assist the country in the present crisis. It will be noticed that in most cases, whether of Government panels of consultants or committees of scientific societies, the services rendered are gratuitous. No particular publicity has been given to this fact; and the majority of people are, therefore, unaware that the best expert scientific and technical knowledge has thus been placed freely at the disposal of the Government. As most scientific work is done for the good of the community instead of the personal profit of the individual, it is usually assumed officially that no payment need be made for it. The reverse is the case in other professions, where expert advice is never expected unless adequate fees are forthcoming. We were given several notable examples of this in a statement issued by the Treasury a few days ago, showing the payments made to the Law Officers of the Crown since 1905. The total amount received by these officers during this period was nearly 250,000*l*. In the year 1912–13 Sir Rufus Isaacs received 16,762*l*. as Attorney-General, and in the year 1913–14 Sir John Simon was paid 14,303*l*. We are glad that attention has been directed to these generous emoluments for legal services, which are essentially non-productive and unprofitable; and we believe that when the public has been sufficiently enlightened as to the relative values of national work in law and science, a readjustment of the rewards made for it will be demanded.

We anticipated that the publication of the list of New Year Honours would show definite public recognition of the national importance of science by the award to a number of leading and representative scientific workers of the distinctions which the country has to bestow. It was reasonable to have this expectation, since, as we have said already, no payment is made to the men of science who have been called in to assist the State with expert advice and judgment. We have now the list of New Year Honours before us; and among the scores of names we do not find a single honour given specifically for scientific work. Several men of science engaged in Government departments, as well as leading surgeons and physicians, are selected for various honours, but outside what may be termed official circles, science is practically ignored.

Many of the honours are rightly given for valour or distinguished action during the present war, but the services rendered by scientific men in order to make the nation strong enough for battle on land or sea under modern conditions are forgotten. It would not be supposed, from the list of honours, that science had anything to do with the war, yet every branch of the Army, Navy, and Medical Services is dependent upon it; and there never was greater need than now of making the utmost use of all that science can offer. Chemists have directed the manufacture of high explosives and fine chemicals urgently needed, and have provided means of protection from poisonous gases; electricians have made it possible for aeroplanes and airships to use wireless telegraphy as a means of rapid communication of intelligence to field stations at a distance of thirty miles or so; mathematical research and physical experiment are responsible for the designs of our most stable aeroplanes; optical science gives our battleships range-finders which will enable ranges to be determined within fifty to a hundred yards at a distance of a dozen miles; and, thanks to the adoption of scientific methods, the incidence of disease among our troops in France has been far lighter than in any previous campaign. It would be easy to multiply these applications of science to modern warfare many times, but national recognition of them is still to be sought.

The honours list includes six new peers; and we are disappointed, rather than surprised, not to find the name of a representative of science among them, though no scientific men have been called to the peerage to fill the gaps caused by

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the deaths of Lord Kelvin, Lord Lister, and Lord Avebury. There are six new Privy Councillors, and three new members of the Privy Council in Ireland; and of the nine, all except one are, or have been, members of the House of Commons, including two Labour members. The total disregard thus shown to the power which scientific men can bring into the chief council of our Sovereign is characteristic of the political mind which advises his Majesty in the selection of men worthy of the honour. The work of science is unknown to political circles; and the road to the Privy Council is not through Burlington House or other centres where scientific men add their contributions to the store of knowledge by which alone can national greatness be ensured, but through Parliament and the market-place, where distinction is not gained by producing-power, but by persuasive rhetoric.

From the national point of view, the Privy Council should include many men of distinguished eminence in pure and applied science, whereas, now that Sir Henry Roscoe is dead, there is not a member of the Council who can be specially regarded as a representative of science. We suppose that this accounts for the fact that the committee of the Council appointed to administer the moneys voted by Parliament for the development of scientific and industrial research does not include a single man of science. Scientific and industrial experts constitute a council to advise the committee, but are naturally subordinate to it. In a State which used true standards of value, each of these experts would be a member of the Privy Council instead of being under the control of a committee which knows nothing whatever of the technical difficulties to be faced. In this country, under the pressure of public opinion, our ministers appoint advisory committees of men of science and engineers for war problems connected with the Ministry of Munitions, Admiralty, the Board of Trade, and other departments of State; but, whereas all the members of these committees would have been made Privy Councillors in Germany, not a single one is given the like honour here. Yet the *Times* can refer to "an exceedingly catholic selection of new Privy Councillors, among whom Mr. Will Crooks is perhaps the most notable and the nearest in accord with the spirit of the time."

We need not attach much importance to the phrase used by our contemporary; yet it is true of the world bounded by the political horizon, where votes count for more than genius. True also it is, and characteristic of the spirit of the time as embodied in the daily papers, that, so far as we have seen, not a single reference has been made to the almost complete absence of the names of scientific men from the list of honours, and the usual satisfaction has been expressed at the selection. The indifference thus shown to science, when all its resources are needed for the successful prosecution of the war in which we are engaged, and for the industrial conflict to follow it, makes us wonder whether our statesmen are capable of understanding what scientific work means to a nation. We live in a scientific age, yet we are governed by men who belong to a century ago; and in their hands, unfortunately for national dignity, lies the division of national honours and emoluments. "Honour and glory and power" are thus much easier won by engaging in politics or commerce than by a career devoted to science. All the benefits of modern civilisation are due to the achievements of science or inventions based upon them; but neither the multitude nor its masters in politics or industry are familiar with the names of the men whose work has provided the comforts and the strength of the present day. While this condition of things persists, science cannot reasonably hope that its meritorious services to the State will receive enlightened attention or just reward.

THE BRITISH COAL-TAR INDUSTRY.

The British Coal-Tar Industry: Its Origin, Development, and Decline. Edited by Prof. W. M. Gardner. Pp. ix+437. (London: Williams and Norgate, 1915.) Price 10*s.* 6*d.* net.

IN this volume Prof. Gardner has collected a series of lectures and addresses delivered on the British coal-tar industry and allied subjects during the last fifty years. These discourses fall naturally into two categories, those delivered before the war and those dealing with the problem of the shortage of dyes arising from the war.

The first three lectures of the earlier series are, very appropriately, the Cantor Lectures of 1868 on the aniline or coal-tar colours by Sir William Perkin, the discoverer of mauve or aniline purple, the first synthetic dye. Successive discourses by other lecturers at first indicated a satisfactory development of the youthful industry in England and France, but in 1881 a note of warning was sounded by Sir Henry Roscoe, the subject being indigo and its artificial production, when the lecturer pointed out that, while the raw materials of the synthetic dye industry were produced in England, the conversion of these crude substances into finished and valuable colours was very largely

effected in Germany. He attributed this early success of the German competitors to three causes —the cultivation of organic chemistry, the recognition of the value of scientific training, and the adverse influence of the English law of patents.

From this time onwards the lecturers assume the part of chemical Cassandras, foretelling to unheeding ears the decline of the British coal-tar colour industry. In 1885 the discoverer of mauve dealt with the matter, alleging that the patent laws, the fiscal policy of Great Britain, and the disinclination of British manufacturers to employ well-trained chemists were causes militating against the commercial success of the industry.

Prof. Meldola, in discussing the scientific development of the industry up to the year 1886, advised the English manufacturer "to look after the science and leave the technique to take care of itself."

The effect of scientific research on the cost of the dyes was strikingly brought out in the Hofmann Memorial Lecture delivered in 1896, when it was stated that magenta, which was formerly worth three guineas an ounce, could then be bought at 2*s.* 9*d.* per pound. An instructive summary of the relative progress of the industry in England and Germany during the period 1886–1900 was given by Prof. Green in a paper to the British Association in 1901. In this publication the author denounced in scathing terms the English manufacturer who "considered that a knowledge of the benzol market was of greater importance than a knowledge of the benzol theory," and the conclusion was drawn that "it is not so much the education of our chemists which is at fault as the scientific education of the public as a whole."

The indigo crisis arose in 1901, when it was realised that the problem of the artificial production of indigotin had been successfully solved. The history of this wonderful achievement, involving many years of intellectual labour and organised scientific team-work, was narrated by Dr. Brunck at the opening of the Hofmann House in Berlin in 1900. A translation of his lecture is given almost *in extenso*.

A portion of the Presidential Address to the British Association in 1902 is devoted to the topic of "applied chemistry, English and foreign." Read in the light of recent events, Sir James Dewar's words have a knell of prophecy fulfilled. "To my mind, the really appalling thing is not that the Germans have seized this or the other industry, or even that they may have seized upon a dozen industries. It is that the German population has reached a point of general training and specialised equipment which it will take us two generations of hard and intelligently-directed educational work to attain. It is that Germany possesses a national weapon of precision which must give her an enormous initial advantage in any and every contest depending upon disciplined and methodised intellect."

In 1905 Prof. Meldola disposed of the plea that the colour industry declined in England for want of duty-free spirit. Incidentally he also demonstrated the inaccuracy of the view sometimes expressed that the colour manufacture was stolen from us by our foreign competitors. The cause of our decadence is mainly the discovery of new colouring matters by foreign chemists. Prof. Meldola's reference to the lot of the few research chemists in any English works will appeal very forcibly to those who have undergone this ordeal. "We were but a handful of light skirmishers against an army of trained legionaries."

Of the lectures and addresses delivered during the war period one may select Lord Moulton's discourse on the manufacture of aniline dyes in England. This discourse deals with the prevailing shortage of dyes, the cause of German supremacy in their manufacture, and the means to be adopted to establish a British dye industry. The formation of a large national company is advocated, a company which is to be co-operative between the producer and consumer.

The compiler of this volume contributes two articles to this discussion of the character of the new company, and insists that "it is foredoomed to failure unless a scientific rather than a purely commercial spirit permeates the management." Similar views are expressed by Prof. Frankland in a very illuminating synopsis of the chemical industries of Germany. "If the proposed undertaking is to succeed, real chemists must be on the directorate, and in a sufficient proportion to give effect to their views." After recounting the history of German chemical industry and illustrating the magnitude of the chief branches of this trade, the lecturer emphasises the difficulties attending the rehabilitation of chemical industries in this country owing to the attitude of the influential classes of the population towards science in general and towards chemical science in particular.

The two concluding chapters are the Presidential Addresses for 1915 to the Institute of Chemistry and to the Chemical Society. In the former of these addresses Prof. Meldola, after referring to the warnings he uttered thirty years ago, pleads for scientific guidance and direct expert assistance in the management of our chemical factories. In the latter address Prof. W. H. Perkin, in discussing the possibility of recovering some of the lost chemical industries, urges a close alliance

between the works and the research laboratories of the universities. He also deals with the prospects of the new dye company, and suggests certain lines along which this enterprise might develop to the best advantage. G. T. M.

SCHOOL MATHEMATICS.

(1) *A First Book of Arithmetic.* By S. Lister. Pp. vii + 258. (London: Macmillan and Co., Ltd., 1915.) Price 1s. 6d.

(2) *Elementary Algebra: First Year Course.* By F. Cajori and L. R. Odell. Pp. vii + 206. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1915.) Price 3s. net.

(3) *Revision Papers in Algebra.* By W. G. Borchardt. Pp. vi + 152 + Answers. (London: Messrs. Rivingtons, 1915.) Price 2s.

(4) *Tables for Converting Shillings, Pence, and Farthings into Seven Places of Decimals of a Pound; and for the Reconversion of Decimals.* Pp. 6. (London: C. and E. Layton, n.d.) Price 1s. net.

(5) *The Rapid Reckoning Chart.* By Dr. E. E. Fournier d'Albe. (London: Educational Supply Association, Ltd.) Price 3d. net.

(1) THE decimal fraction is the central point of modern arithmetic. This is realised by Mr. Lister, who begins his book with the graphical abacus. The explanation of its use for integers leads up very simply to its use for decimal fractions. All other aids are also pressed into the service, such as the use of metric measurements, expression of a decimal in words as so many tenths and hundredths, and the actual measurement of lengths by a suitably divided ruler. It is, in fact, difficult to see how the dullest boy can fail to grasp the idea as presented by Mr. Lister.

We are pleased to see a book on arithmetic compressed within little more than 200 pages, but rather regret the suggestion contained in the title "A First Book of Arithmetic" that further books on the subject must be used. The title may, however, be nothing more than a concession to custom. Similar concessions are seen in the very elaborate tables of money and measures and in the conversion between different systems of measures. Such concessions are not only pardonable; they are necessary if a book is to succeed. We wish the book all success; it is the best we have seen for a long time.

(2) This book on elementary algebra is pleasing in several ways. It contains historical notes on the development of algebraic notation, including the remarkably clever notation in use among the Egyptians nearly four thousand years ago. There are also portraits of famous mathematicians, with historical notes. The type is pleasant to the eye and eminently legible, and the general get up of the book attains the usual high American standard. Graphs are suitably introduced by a temperature curve and a graph of the price of coal; and the treatment of the multiplication of negative quantities is the best we have seen. Yet, when we come to the essence of an algebra, the problem, we find all the old unnatural riddles and never a hint of a problem that is real or connected with daily life; and this in a book to which a famous American professor lends his name. When we consider the advance that has been made in England we are tempted to thank God that we are not as other nations are, and to derive more pleasure in this way than from all the merits of the book.

(3) With the ink upon our pen still wet from our pharisaical boast, we turn to the "Revision Papers in Algebra" and find ourselves liable to the question, "Wherein is this book better than the other?" It is true that this book also contains no natural problems. The natural problem belongs chiefly to the beginnings of the subject, and the student who carries his studies on to indices, surds, binomial theorems, and manipulation must not expect them. The questions before us are fully as good as he has any right to expect. His proper course is to study the calculus instead, or, if he is too weak a mathematician for that, to drop the subject of mathematics. Meantime examiners require this stuff, schools teach it, the pupil must know it, and Mr. Borchardt meets their needs admirably.

(4) The calculating machine arrived some time ago, and some of the results of its arrival begin to emerge. The imperial system of weights and measures does not fit the calculating machine. The machine will not (without assistance) tell you the price of 3 tons 7 cwt. 30 lb. of copper at 60l. 17s. 4d. a ton. So far as pure money calculations are concerned, the necessary assistance is provided by the tables we have before us for expressing any sum of money as the decimal of a pound sterling and *vice versa*, an excellent and well-printed table of four pages. The sum of money prepared by this table is put into the machine, and the result provided by the machine is restored by the table to its usual form. In some happy future we shall decimalise our money once for all by Act of Parliament. Until then these tables by Messrs. Layton have great value as a labour-saving device.

(5) Dr. Fournier d'Albe's ingenious chart is a graphical computer which will perform various operations up to the extraction of the cube root.

It gives the result of the operation within 1 per per cent., a serviceable degree of accuracy. If it is as successful as it deserves to be, perhaps in a new edition the publishers will consider whether a somewhat larger scale is possible, and whether the instructions can be made visible at the same time as the chart. D. M.

THE NORTHERN BANTU.

The Northern Bantu: an Account of some Central African Tribes of the Uganda Protectorate. By the Rev. J. Roscoe. Pp. xii + 305. (Cambridge: At the University Press, 1915.) Price 12*s.* 6*d.* net.

MR. ROSCOE is too well known as an ethnologist to require any introduction to the readers of NATURE, who if they are studying the Negro people of Africa will read his new book as eagerly as its predecessors, or those admirable articles from his pen published in the Journal of the Royal Anthropological Institute.

The book under review deals with the physical appearance, manners, customs, beliefs, numbers, and to some extent birth-rate, of the following (more or less) Bantu tribes of the Uganda Protectorate—the Banyoro, Ankole, Bakene, Basoga, and Teso. The Teso are Nilotic in speech, and their inclusion in a review of the Bantu-speaking peoples of eastern Equatorial Africa is only a matter of propinquity.

According to Mr. Roscoe, the Bantu area of the Uganda Protectorate must be considerably extended beyond what was accorded to it in previous conceptions. He writes of the *Bakene* as a most interesting Bantu tribe in the very centre of the Uganda Protectorate, dwelling in floating huts on the Mpologoma River, on Lake Kioga, and on Lake Salisbury. He also adds, "I believe, on Lake Rudolf." He does not give us any reference for this last suggestion, which, if well confirmed, would be most interesting, as it would give us the farthest north known of any Bantu or semi-Bantu tribe in eastern Equatorial Africa. Oskar Neumann, who explored these regions between Uganda and Abyssinia about 1898–99, contended that he had traced the Bantu "type" as far north as southern Galaland (the Omo River basin, etc.). Presumably he meant "physical type," and so far as the Bantu have any generalised physical type (though it is more and more difficult to attribute such to them), it is certainly to be met with in the country of Karamojo west of Lake Rudolf. Moreover, not a few place-names and tribal names in that region suggest the previous existence of Bantu-speaking people before a succession of conquests and colonisations by the Nilotes. Mr. Roscoe says that the Bakene of Lake Kioga are allied to the Basoga, and speak a language or a dialect very similar to Lusoga. Now Lusoga is so close to Luganda that it cannot be accorded more than a dialectal difference. Consequently, if his deductions regarding the Bakene (not supported, however, by any vocabulary) are correct, they are in common with the Basoga and the Basese, outlying clans of the original Baganda nation.

Mr. Roscoe attributes to the Bagesu of western Mount Elgon the practice of eating a portion of the corpses of their dead and throwing the rest to the wild beasts. He rightly alludes to the very "Negro" appearance of the Bagesu and their low status in culture, and remarks on this as being so extraordinary when they are surrounded by both Bantu and Nilote people of handsome physical development and rather remarkable advance in native civilisation. I noted the same fact in my "Uganda Protectorate," and gave therein photographs of Bagesu types to illustrate their physical resemblance to the Forest Negroes and the Congo Pigmies. But my own visit to their country, together with indications given by Mr. C. W. Hobley, revealed the interesting fact that the Bagesu speech may be cited as perhaps the most archaic form of Bantu language. It is one with very elaborate prefixes and preprefixes, and is a highly developed speech, probably imposed on these forest savages at a comparatively ancient date by the first Bantu invaders of eastern Equatorial Africa, just as the Congo Pigmies and Forest Negroes of Central Africa now speak for the most part Bantu tongues or languages imposed on them by the Sudanic negroes and negroids.

Unfortunately, the photographs specially taken by Mr. Roscoe for the illustration of this work failed to materialise, owing to the breakdown of his apparatus, and although the book contains a number of interesting illustrations, they are not always apposite to the author's descriptions. Nevertheless, some of these are of great interest, especially that of the King of Bunyoro wearing the special hat for the "secret court."

This last book by Mr. Roscoe will confirm many in the impression that much indirect and ancient Egyptian influence has penetrated to the negroes of northern Equatorial Africa, especially the Bantu, and has been the foundation of most of their religious beliefs and customs. It would almost seem as if from this and that deduction there had been a former continuous tribe to tribe

intercourse between the southern frontiers of the Egyptian empire and the regions bordering Mount Elgon and the division of the Niles, and that some subsequent invasion of the eastern Sudan by the Nilotic Negroes acted more or less completely as a barrier for any further penetration of the white man's ideas from the direction of Egypt and Abyssinia.

H. H. JOHNSTON.

OUR BOOKSHELF.

Quantitative Laws in Biological Chemistry. By Dr. S. Arrhenius. Pp. xi + 164. (London: G. Bell and Sons, Ltd., 1915.) Price 6*s.* net.

UNTIL recently, elementary Greek was considered a necessary part of medical education, though it was scarcely possible to justify its inclusion on the ground of utility. Higher mathematics may well take its place, for it becomes increasingly plain that a real working knowledge of it will soon be indispensable for the student of biology or medicine, whether he is content to follow modern developments or aspires to aid its progress. The present work, Arrhenius's latest contribution to the science, is convincing proof of this tendency.

The substances concerned in biochemical reactions are frequently present in such minute quantity, and associated with large amounts of other organic substances, that the older chemical methods are of little use, and recourse must be had to the newer methods of physical chemistry. How this may be done, and the nature of the results, are all to be found in this important book.

Among the subjects dealt with are enzymes, toxins, antibodies, specificity, digestion and resorption, and immunity. Detailed criticism is out of the question, but attention may be directed to the discussions on researches "in vivo" and "in vitro" (p. 84); on relationship, or, literally, consanguinity; and on the "poison spectra" of Ehrlich and the supposed plurality of toxins (p. 118). For example, by applying to the neutralisation of boric acid by ammonia the same reasoning which led Ehrlich and Sachs to divide diphtheria toxin into ten different partial-poisons, Arrhenius found that ammonia must contain six partial-poisons; these conclusions are shown to be due to the errors of observation.

In view of the large number of valuable data and results brought together in the book, the index might with advantage have been a little fuller.

W. W. T.

The "Wellcome" Photographic Exposure Record and Diary, 1916. Pp. 257. (London: Burroughs Wellcome and Co.) Price 1*s.*

THIS is a handy pocket-book with pencil; it contains a diary of useful though small dimensions, ruled pages with columns suitably headed for recording the details of negatives and prints made during the year, an exposure calculator with tables suitable for all possible conditions, formulæ with concise instructions for a very considerable number of photographic operations, and other information of the kind that amateur photographers are most likely to need. The formulæ are, of course, given in terms of the firm's tabloids. The weight of the ingredient in each of these is given in many cases. There does not appear to be any good reason why there should be any exception to this, and then photographers would be able to take the very fullest advantage, intelligently, of the convenience of the tabloid system. The three photographs of war subjects, and the one taken on Sir Douglas Mawson's Australasian Antarctic Expedition, are excellently reproduced.

Hazell's Annual for the Year 1916. Edited by Dr. T. A. Ingram. Pp. lxxii + 623. (London: Hazell, Watson and Viney, Ltd.) Price 3*s.* 6*d.* net.

A NOTABLE characteristic of the thirty-first issue of this popular annual book of reference is the detailed list of more than a thousand learned societies and institutions which it contains. Though as far as possible the editor has retained the usual contents of the volume, it is very naturally this year a war edition. Not only has a large amount of space been absorbed by the events of the great struggle, but also many of the more general articles have been written from the same point of view. The annual is as useful and comprehensive as ever, and the editor may be congratulated on the way in which he has surmounted the special difficulties of compilation at the present time.

Scientific Ideas of To-day. A Popular Account of the Nature of Matter, Electricity, Light, Heat, etc., in Non-technical Language. By C. R. Gibson. Fifth edition. Pp. 344. (London: Seeley, Service and Co., Ltd., 1916.) Price 5*s.* net.

THE first edition of Mr. Gibson's popular book was reviewed at length in our issue of April 15, 1909 (vol. lxxx., p. 181), and it will be sufficient to say of the present edition that it has been revised and brought up to date. Recent advances in the knowledge of the constitution of matter and the nature of X-rays have been incorporated, and the electron theory is given due importance.

The Scientists' Reference Book and Diary, 1916. (Manchester: James Woolley, Sons and Co., Ltd.) Price 2*s.*

THE reference book and diary are separate publications enclosed in an attractive leather case for carrying in the pocket. The former includes the numerical and other data which the worker in science likes to have readily available, and the latter, in addition to the usual diary, has abundance of space for memoranda.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Researches in Aeronautical Mathematics.

THE intimation in the columns of NATURE that I should be glad to receive offers of collaboration in the solution of problems in the applied mathematics of aeroplanes has, as I am pleased to state, met with a reply from Mr. Sely Brodetsky, lecturer in the University of Bristol.

Mr. Brodetsky has now definitely taken over the problem of the two-dimensional motion of a lamina in a vertical plane, with special reference to cases in which the equations of motion can be integrated either by methods of approximation or otherwise. The only cases previously studied appear to be Lanchester's "fugoid" and allied types of motion, and the small oscillations about a steady state of motion in which the plane of the lamina makes a small angle with the direction of flight. Other possible types of motion are those in which the lamina turns over and over in its descent, or performs oscillations about a state of steady descent in a vertical line with the plane of the lamina horizontal.

As these types of motion may occur when an aeroplane becomes uncontrollable, it should be evident that such investigations offer a considerable prospect of leading to results of practical utility.

Various empirical forms have been proposed for the resultant pressure on a plane lamina or the co-ordinate of its centre of pressure when expressed as functions of the angle of attack. Among the former, Duchemin's formula is probably the best known. It is convenient for purposes of comparison to choose the coefficients and constants so as to make the pressure unity when the angle of attack is 90°. Under these conditions Duchemin's expression becomes

$$\frac{2\sin\alpha}{1+\sin^2\alpha}$$

The use of Fourier's series affords a convenient method of standardising and comparing such expressions, and the results of experiment. Duchemin's formula is easily expanded by means of De Moivre's theorem in the form:

$$(4-2\sqrt{2})(\sin\alpha+r\sin 3\alpha+r^2\sin 5\alpha+\ldots),$$

where $r=3-2\sqrt{2}$.

Mr. T. G. Creak, of Llanberis, has evaluated the coefficient in this series as well as in a number of formulæ proposed by other writers, and Mr. W. E. H. Berwick has assisted. The investigation is now being continued by Mr. Caradog Williams, a post-graduate student in my department, who is applying Fourier series to the results of experiment, and, in particular, to the tabulated results given by M. G. Eiffel in his "Resistance of the Air and Aviation."

The results, which are extremely interesting, indicate that the method is advantageous in several respects; in particular, the Fourier expansions, while being of uniform *standard* types, are sufficiently *elastic* to be applicable to the most varied forms of plane and curved surfaces. In the case of plane surfaces we have the following results:—

(1) The resultant pressure can be expanded as a sum of sines of odd multiples of the angle of attack, the expansion holding good from 0° to 360°. The series usually converge according to the "inverse square" law. The first coefficient usually lies between 1·0 and 1·25, and the second between 0 and 0·25. The extreme limits, 1·25 and 0·25, represent the values according to Soreau's formula, and are rather in excess of those deduced from most of Eiffel's experiments.

(2) For small angles of attack the sine series may sometimes be inconvenient, and it is preferable to express the result as the product of $\sin\alpha$ into a series of cosines of even multiples of α. From this cosine series the series of odd sines is immediately deducible, but the converse is not possible until the first (or constant) term of the cosine series has been evaluated. In future calculations it may, therefore, be better to start with the cosine series.

(3) The series for the lift and drift are immediately deducible.

(4) The distance of the centre of pressure from the centre of area is given by a series of odd cosines, and the moment of the resultant thrust about the centre of area by a series of even sines.

Mr. Williams and I are also employing the method of least squares to obtain expansions in the case of curved surfaces when the results are only required for a limited range of tabulated values, and as the method of least squares leads to Fourier's expansion as a particular case, whatever be the number of terms that it is desired to retain, comparison of results should be easy.

While it may be sufficient for many purposes to adopt a formula of the type $A_1\sin\alpha+A_3\sin 3\alpha$ for the resultant thrust, the first two terms are not sufficient to give the correct position of the maximum in Eiffel and Denes's results for square plates. In very few cases is there any advantage in going beyond $\sin 5\alpha$.

The method is obviously applicable to an aeroplane considered as a whole, and it thus opens up a number of problems on longitudinal motion, equilibrium, and stability. In particular the conditions may be studied under which there is only one unique possible state of steady motion. This condition does not lead necessarily to the evolution of a non-capsizable aeroplane analogous to the non-capsizable lifeboat, as equilibrium can still be broken by the types of looping motion mentioned earlier.

The programme of work does not stop anywhere near this point. The most important task before us is to apply the method of initial motions to investigate the effect of atmospheric disturbances—in other words, suddent gusts of wind. For this problem the Fourier method will be very useful in dealing with longitudinal disturbances, but it is not so easy to decide on a suitable expansion when lateral changes of wind velocity are taken into account.

The motion of a kite was investigated by Prof. Bose in the Bulletin of the Calcutta Mathematical Society, ii., 1; unfortunately, however, an examination of the paper by Mr. W. E. H. Berwick and myself reveals a number of errors in the equations, and the form in which the tension of the string is taken into account renders the solution totally inapplicable to any system resembling an ordinary kite. The only thing possible in the circumstances was again to formulate the correct equations of motion, which appear to be rather complicated, entirely *de novo*, in the hope that Prof. Bose or some other mathematician may be able to do the rest. It would be an advantage if two workers could attack the problem independently. It is not encouraging to find that a problem which was supposed to be relegated to the shelf as having been solved requires to be reinvestigated.

The effects of propellers on the equilibrium and stability of aeroplanes require careful classification.

In addition to the constant torque of the propeller, and the gyrostatic effects due to its rotatory inertia, the propeller introduces a number of additional terms into the resistance derivatives, thus mixing up the longitudinal and lateral oscillations. I propose that a theoretical basis of comparison should be worked out for these coefficients by treating the propeller blades as "narrow planes gliding at small angles" in a medium the resistance of which follows the sine law. Whatever objections may be raised to this assumption, it will at any rate lead to some definite conclusions with which results of experiment can be compared.

I have for a long time past expressed the hope that it may be found possible to develop the tandem propeller with blades rotating in opposite directions, the rear propeller having the higher pitch.

Practical experts state that the system has proved a failure. It would be interesting, however, to learn whether this is because there is no perceptible gain of efficiency, or whether there is really a serious loss of efficiency. To get rid of the unsymmetrical action of the propeller would be worth some sacrifice of efficiency.

Mr. R. Jones, late of this college, who is now working with Mr. Bairstow in the National Physical Laboratory, has just contributed a paper to the Royal Society on motion of a stream of finite breadth past a body (see NATURE for November 11, p. 304).

It will thus be seen that while we are making a fresh start in the study of the rigid dynamics of aeroplane motions, more recruits are needed if we are to arrive at anything approaching a clear understanding of the subject before the end of the war. In the meantime every aeroplane is to be regarded as a collection of unsolved mathematical problems; and it would have been quite easy for these problems to be solved years ago, before the first aeroplane flew. I have seen no reference to aeroplanes in connection with Section A of the British Association; and this in war-time! It would be quite impossible for me in the circumstances to divert my attention to the practical aspects of aviation, for to do so would only add to the collection of unsolved problems. It therefore became necessary for me to resign from the committee of the association Mr. Blin Desbleds is endeavouring to form, and it is further necessary for me to disclaim any connection with a Government committee such as has been recently announced in certain sections of the Press.

G. H. BRYAN.

University College of North Wales, Bangor.

Belated Migrants.

IT may be of interest to the ornithological readers of NATURE if I place on record that on the morning of December 27, just as the gale of the previous night was abating, and in a gleam of sunshine that broke through for nearly half an hour about 10.30, I observed against the blue sky a flock of birds flying over Wilton Park (on which my house gives) with a very herundine flight. They were excitedly disporting in the wind, wheeling and gyrating, just as they do so often prior to their autumn migration. At first I thought they must be starlings; but on their coming close overhead the white in their plumage showed them to be martins. There were from a dozen to a score of them, and they were moving in a northerly direction; but as I was starting to catch a train, I could not, to my regret, watch them longer, and that bearing may not be the course they afterwards pursued. Whence had they come, and whither were they bound?

It may be perhaps also worth mentioning that for the past fortnight our hedgerows here and the Wilton and Burnham woods have been quite resonant with the spring songs of many species of birds. The thrush and the blackbird have been especially vociferous for more than a week, each day adding to the melodiousness of their song. The latter have been engaged, often half a dozen at a time, in quite spectacular love-tournaments in my garden—where the snowdrops are already some time in flower—for nearly three weeks past. Now and again a soaring lark also fills the air with his melody. May such early harbingers of spring presage a new year "happy and victorious"!

HENRY O. FORBES.

Redcliffe, Beaconsfield, Bucks, January 1.

The Popularisation of Science.

I HAVE read with interest the several articles you have recently published on the position of science in England, and would like to be allowed to make a few remarks on the subject.

It is scarcely surprising that scientific knowledge is so little disseminated in this country considering the difficulties which hinder its acquisition. If science is to become widespread, it seems to me essential that it should be democratic both in its higher and its lower branches. In England, however, science may be said to be aristocratic. Scientific societies demand more or less high subscriptions. Public lectures on science are rarely free. In London an institution exists where advanced lectures are given, but the subscription to which is considerable, and to become members of which people have actually to be recommended—recommended to be allowed to learn!

In France matters are different. The membership of scientific societies is moderate, and higher scientific education is provided *gratuitously* by the State at the Collège de France, the Sorbonne, and elsewhere. There are many instances in France of men devoting themselves to research from purely intellectual motives, and in most classes in that country the scientific spirit is displayed.

F. CARREL.

Bath, December 16.

THE EXPORT OF FEEDING STUFFS AND FERTILISERS.

RECENT correspondence in the *Times* has revealed a certain amount of uneasiness at the export from this country of fertilisers, linseed cake and other feeding stuffs, which go to neutral countries, but, it is suggested, do not stop there, as the quantities are in excess of normal consumption. It is urged on one hand that the proper maintenance of the balance of trade requires the export of as many commodities as possible, and, on the other, that any fertilisers and feeding stuffs which found their way to enemy countries would obviously prove extremely valuable to them.

The fertiliser mainly concerned is sulphate of ammonia. About 400,000 tons of this are normally produced here each year, of which 300,000 are exported, Japan taking about 100,000 tons, Spain 60,000, the Dutch East Indies and the United States each about 40,000 tons, and so on. Holland only takes a little: no more than 3000 to 3500 tons per annum. At the present time foreign shipments are of course only allowed under licence, but it is stated on the authority of a trade publi-

cation that licences are now granted to Holland to the extent of 5000 tons per month, that is, seventeen to twenty times the usual quantity. As Great Britain is the chief exporting country, supplying both France and Germany (in addition to their own production), it cannot be urged that Holland is cut off from its usual sources of supply, and one may well ask what becomes of the difference between 250 tons of normal monthly imports and the 5000 tons that will be imported monthly if the present licence is correctly described and continues in force.

The obvious suggestion is that it finds its way to Germany. But one ought not too hastily to accept it. Five thousand tons of sulphate of ammonia per month is not a small quantity that could be smuggled over a frontier unknown to the authorities, and the licence would presumably be revoked if any extensive smuggling were discovered. It is at least possible that the fertiliser is wanted for trans-shipment. The Dutch East Indies take very considerable amounts of sulphate of ammonia for fertilising the sugar canes: in 1914 56,000 tons were imported for the purpose. Here, of course, there is no question of enemy benefit. Further, the United States only received one-third of their usual amount during the first six months of 1915, and Japan only about one-fourteenth. There is therefore a considerable margin to be made up.

In the December number of the *Journal of the Board of Agriculture* a very straightforward account is given of the work done by the Special Enquiries Branch of the Board during the first twelve months of the war. It is stated that the Board draws up systematic monthly reports showing the supplies of agricultural commodities, and that it acts as adviser to the War Trade Department, which gives to traders the necessary licences to export. The Board has therefore the facts in its possession, and no one can reasonably doubt that it looks after the interests of the farmer. It is pointed out in the article that prohibition of export is not altogether simple: apart from the question of balance of trade it was necessary to enter into mutual arrangements with certain neutral countries who supplied us with butter, margarine, bacon, eggs, etc., to maintain normal conditions so far as possible; we sending out fertilisers and feeding stuffs, and they returning the usual human foods.

This consideration obviously cannot be neglected. The Board has, however, laid down the general rule that no licences to export fertilisers and feeding stuffs should be given until the British farmers' requirements are satisfied, and to this end it made an arrangement last autumn with the dealers in sulphate of ammonia whereby farmers were able to buy at 14*l*. 10*s*. per ton until the end of December. Many availed themselves of the opportunity. The arrangement has now terminated, and the dealers are already asking 16*l*. 15*s*. per ton. This, of course, is not proof that the British farmer has not enough, but simply that prices abroad are higher than in this country. If farmers have to pay the present high price they have only themselves to blame for neglecting to secure their stocks while they had the chance.

The whole question turns on the amount the British farmer requires. Not long ago the Board issued a circular suggesting that farmers should top-dress their wheat with about 2 cwt. sulphate of ammonia. There are in the country two million acres under wheat, and if all this land received the dressing 200,000 tons would be required—probably most of our present production available for export. But the whole of the land could not receive 2 cwt. per acre, nor did the Board suggest it. On the other hand, the hay land could very well receive more sulphate of ammonia than it now has. Further, the restriction in the supply of nitrate of soda is bound to increase the demand for sulphate of ammonia for other crops. It is certainly not easy to decide exactly how much the British farmer does want or will use, but as the Board is in close touch with the county authorities it ought to have no difficulty in knowing the position at any time.

There is another aspect of the matter that ought not to be overlooked. Ammonia is convertible into nitric acid, and in Germany the process is actually carried out. We may hear of a similar development in this country, and in that case the margin for export would be lowered still further.

Superphosphate and basic slag are both exported from this country in normal times, and the export is still allowed under licence. Probably many farmers would be prepared to use more than they have in the past, but the universal complaint is that they cannot get delivery. We are somewhat in the position of the days before railways, when it was often easier to send things abroad than to deliver them in England.

The facts do not justify the assertion of some of the correspondents that the Board has been unmindful of the interests of the farmer. Assuming that steps are taken to prevent leakage to enemy countries, there can be no objection to the export to neutrals of any excess of fertilisers and feeding stuffs over and above the requirements of our own farmers. These are higher than in normal times, though it is difficult to say by how much. Long-period licences for export ought, therefore, not to be allowed, but there seems no objection to the short-period licence.

A greater difficulty is transport. It would be worth inquiring whether fertilisers and feeding stuffs ought not to rank as Government goods on the railway, and have precedence over ordinary commodities. If, in addition, an arrangement were made similar to that with the sulphate of ammonia producers, viz., fixing a price and issuing no licences until home wants are supplied, farmers would be enabled to purchase abundant supplies at reasonable prices. Remembering that 1 lb. of sulphate of ammonia, in suitable conditions, often yields more than 2 lbs. of wheat, the advantages of ample dressings are obvious.

THE CERAMIC INDUSTRIES.[1]

THE intimate relation between the various industries and clay is seldom appreciated. The gas industries, coking plants, iron, steel, and non-ferrous metallurgy; glass manufacture; and the ceramic industries are all to a large extent dependent on good refractory materials. It is therefore obvious that a manufacturing country must devote much attention to its clays, for progress in these industries is largely dependent on improved refractories. In the pre-war days, consumers were pushing the firebrick manufacturers for improved methods of manufacture to meet the more severe fire-tests imposed by modern conditions. It was the custom to vaunt the German methods of manufacture, and to condemn the benighted British. There is much truth in the old firebrick manufacturer's contention that God has given each manufacturer particular clay-beds, and that no improvements in methods of manufacture will make a bad clay into a good one. As a matter of fact, there appears as much difference in the character of clays from different beds as there is between different individuals; and to get each clay to do its work most efficiently it must be humoured in manufacture and in use. If the firebrick be not in a suitable environment, it will break down. Experience is constantly bringing to light cases where good firebricks do satisfactory work in one furnace, and fail in another, where, at first sight, the conditions appear similar, thus showing that firebricks are sometimes very sensitive to local conditions.

Satisfactory progress can be made only by the co-operation of maker and user. The experience of both must be pooled for the common good. We can then find what clays are best adapted for particular purposes, and the manufacturer will have a more clear and definite idea in what directions he can best modify his methods to make his clays do their best work. This gigantic task has been undertaken from the point of view of the gas engineers under the energetic lead of Mr. S. J. Bywater, and slow progress has been made in certain directions. To hasten the final victory, the Geological Survey can help very materially. We want to know the specific character of the different clay beds in the country, and a host of other questions which can best be answered on the geological side. There have been a score of elaborate reports on the clay deposits of different parts of the United States, and half-a-dozen likewise for Canada. Several of these have the character of pot-boilers, and cannot be of much practical use; a few photographs of clay-banks, a few diagrams from the machinery catalogues, and a few clay analyses do not fulfil the required purpose. In England we have lagged far behind even this. We therefore welcome with pleasure the appearance of the work on "China Clay and Cornish Stone" by Mr. J. Allen Howe, curator of the Jermyn Street Museum (1). Is it too much to hope that this work is the forerunner of a series dealing with the whole of the different types of clay in our country? This particular memoir is of most use to the pottery industry, since the materials here discussed have some special qualities which are not required from fire clays *per se*, and which give the china clays a special commercial value. The mere fact that the pamphlet has appeared is a hopeful sign. It has long been the plaint of the clay industries that a great deal of public money has been spent year by year to publish a pile of Memoirs of the Geological Survey of the United Kingdom. Of course, pure geology is exceedingly important and necessary, but why the applications should have been virtually neglected is not always clear.

In the introduction to his brochure, Mr. Howe makes a contribution towards rectifying the general muddle as to the precise meaning of the terms "china clay" and "kaolin"; he then gives a general description of the methods of extracting china clay practised in the south-west of England; then follows a general sketch of the distribution of china clay in various parts of the world. There are also discussions on Cornish or China stone; on the uses of these materials; and on the origin of china clay. There is a review of some recent work on the nature of kaolinite and related minerals. This is followed by a collection of analyses, physical tests, statistics, and a bibliography. Mr. Allan B. Dick contributes an exceptionally valuable appendix on the identification of transparent mineral grains under the microscope.

There are some very useful and trustworthy data in the chapter on analyses and physical tests. These are mixed with a lot of old and inaccurate work which possibly might have been omitted without the loss being felt. Perhaps, however, there is something in the argument that bad data are better than no data at all. The table of exportation of china clay to foreign countries recalls a scandalous anomaly. We know that before the war several factories on the Continent were purchasing English china clay delivered on the works at a lower price than that paid by the Staffordshire potters. It appears that in 1913 Germany purchased more than 70,000 tons at about £80,000; this is interesting in view of the investigations recently made at Charlottenburg with the patriotic object of displacing English china clays by German clays *in Deutschland*.

In "A Study of Atterberg's Method of Measuring Plasticity" (2) Mr. C. S. Kinnison compares the results made by Atterberg's method with those based on wet to dry contraction of clays, and on the water of plasticity method. The results are not very promising. This is not surprising. In my opinion, plasticity is a mechanical property, the magnitude of which is primarily estimated by the potter's thumb, and unless the proposed methods measure approximately the same mechanical property they do not measure plasticity at all, but rather some other quality of clay.

[1] (1) "A Handbook to the Collection of Kaolin, China Clay, and China Stone in the Museum of Practical Geology." By J. Allen Howe, Curator. With an appendix by Allan B. Dick. (London, 1914.)
(2) "A Study of the Atterberg Plasticity Method." By C. S. Kinnison. No. 46. Technological Papers of the Bureau of Standards. (Washington, 1915.)
(3) "Preliminary Report on the Clay and Shale Deposits of the Province of Quebec." By J. Keele. Memoir 64 of the Canada Geological Survey. (Ottawa, 1915.)

The report by Mr. Keele on the clays of Quebec (3) shows that Canada recognises the importance of a definite knowledge of its clay resources. In the preface Mr. Keele says: "Chemical analyses are of little value to him (*i.e.*, the clay-worker), as practically no information regarding the behaviour of clays can be derived from such analyses." This might be true if the statement refers to *some* clay-workers; but it does not require a Gaboriau's Lecoq to deduce a very great deal of important practical information from the analysis of a clay, information, too, which could be otherwise gleaned only after painful processes of trial and failure. The methods of collecting the so-called practical data are largely those followed in the preparation of numerous other reports published further south. This is good so far as it goes, but we must remember that some of the best of these reports were pioneers in this department of clay literature, and have served a very useful purpose. There are many important properties of clays which the progressive worker ought to know which might advantageously have been included. New knowledge, new requirements. Of course, Mr. Keele's report is mainly of local interest, and without a knowledge of the particular district covered by the memoir it can be said that the present report compares very favourably with the best of those made for other localities.

J. W. MELLOR.

SCIENTIFIC STUDIES OF SWINE FEVER.[1]

THE committee appointed by the Board of Agriculture and Fisheries to inquire into swine fever has issued its final report, which contains conclusions of far-reaching importance, and since the main conclusions are based on the results of experimental investigation carried out on the recommendation of the committee by one of its members, Sir Stewart Stockman, who is also the Chief Veterinary Officer of the Board, the report would appear to portend an early radical change in the campaign against the disease.

The causal agent of swine fever is a living organism which is beyond the range of microscopic visibility, and will pass, with fluid containing it, through the pores of the finest bacterial filter. No method of cultivating it artificially has yet been discovered.

Amongst its conclusions, the committee makes the following statements:—That the manure of pigs suffering from swine fever is infective, and that a period of fourteen days may be regarded as sufficient to bring about the disinfection of infective manure through natural causes; (one member of the committee, however, Prof. Penberthy, considers that the experiments on which the latter view is based are not conclusive, and that further experimentation on the point should be undertaken before being accepted as a basis for administrative measures); that rats are not, as has been suggested, pathological carriers of swine fever, and that all the available evidence suggests that swine fever is not disseminated by external parasites, such as lice and fleas; that while persons, vehicles, and animals may carry infective material mechanically, the evidence leads to the conclusion that all wide dissemination of the disease is due to the movement of infective pigs; that a pig may become infective in three days after contracting infection, and before it has actually exhibited clinical symptoms of the disease, and may remain infective for a considerable period, the extent of which has not been fully ascertained; and that there would appear to be cases in which healthy pigs, which have not been visibly affected by swine fever and on post-mortem examination show no evidence of having suffered from swine fever, yet are infective, and continue to be so for a considerable time.

On the question of serum treatment and vaccination as methods of combating swine fever, the committee reports that the serum of a hyper-immune pig, if injected into other pigs, will protect them for a *short time* against swine fever if they are free from infection at the time of treatment, but it is disappointing in the case of young sucking pigs. It has no curative effect. This short period of immunity can be converted into a prolonged immunity if the pigs treated with serum are allowed to come into contact with infection, *i.e.*, by what may be termed "natural vaccination." "Artificial vaccination" may also be carried out. It consists of the simultaneous application of serum injection with an infection produced by the administration of virus by feeding or by inoculation, but the process is attended by greater risks of producing severe forms of swine fever than "natural vaccination."

The committee is of opinion that the continual prevalence of swine fever appears to be due principally to its highly contagious character and the difficulty of its recognition by the pig owner in its early stages and in its milder forms; and the members consider that the extirpation of the disease is practicable only by such drastic measures of slaughter as would involve a prohibitive outlay, and by such severe restrictions on movement as would be fatal to the industry of pig-keeping. New preventive methods, however, may bring about a condition more favourable to the prospect of eradicating the disease.

Recommendations.—In view of all the evidence laid before them, the committee recommends that the attempt to extirpate the disease by general slaughter should be abandoned for the present, and that the immediate object of future policy should be to reduce the mortality from the disease by the use of protective serum as soon as possible in infected herds. The production of immune herds by "artificial vaccination" should be undertaken under suitable conditions. To control the spread of the disease, isolation of infected premises should be maintained, but restrictions

[1] Final Report of the Departmental Committee appointed by the Board of Agriculture and Fisheries to inquire into Swine Fever. Part iv. Final Report, Minutes of Evidence and Appendix. Cd. 8045. Price 8*d*. Can be obtained direct from Messrs. Wyman and Sons or through any bookseller.

should allow of the introduction of fresh pigs to be treated immediately with serum. The committee is strongly impressed by the possibility of artificial vaccination as a method of combating swine fever. It also recognises the advantages that might accrue from the discovery of a trustworthy diagnostic test for obscure cases, and it therefore recommends that investigation into this and cognate matters should be actively continued.

Sir Stewart Stockman's report of his experimental investigation is published with the committee's final report as an appendix, and it contains most important discoveries, both on the question of spread of the disease and concerning immunisation. His proved conclusions on the various aspects of the disease are very numerous, and so very concise that it is impossible to condense them any further for inclusion here. We may, however, refer particularly to the proved existence of the "carrier." It has long been known that a stallion recovered from influenza may continue to infect mares for a considerable period. Stockman appears to have established the fact that a boar, although apparently healthy, may under similar conditions infect sows with swine fever, and they in turn may pass it on to their young. Such then are some of the difficulties of tracing the spread of the disease, especially in the case of an ultramicroscopic causal agent, and in the absence of any known diagnostic agent for obscure cases.

The report and appendix indicate marked progress in our knowledge of the scourge.

MINERAL PRODUCTS OF INDIA.[1]

WHILST he was director of the Geological Survey of India, Sir Thomas H. Holland instituted a system of quinquennial reviews of the mineral production of India, beginning in 1898, and these reviews have appeared regularly every five years since 1903, practically upon the same lines as originally laid down. Their appearance is always a matter of interest to all students of mineral statistics, whether their interest be mainly scientific or mainly commercial, and the present volume, covering the period 1909 to 1913, contains much matter of importance from both points of view.

The two most important, economically, of the mineral products of India are coal and gold; in the five years ending 1908 the average annual output of gold was valued at 2,266,307*l*., and that of coal at 2,139,249*l*., so that the former was the more important, in spite of the fact that the period included the boom year 1908, when the value of the coal output jumped up to more than 3,350,000*l*. In the period now under review the positions of these two items have been reversed, the average value of the coal being 2,969,305*l*. per annum, and that of the gold 2,241,844*l*. It will be noted that the gold output has been practically stationary throughout the whole decade; that of coal showed a drop in 1909 from the boom year 1908, and then a steady increase up to nearly 3,800,000*l*. in 1913, which may be taken as a most satisfactory symptom, and as indicating that the Indian coal trade is now on a firm and stable basis. The output in 1913 had reached a total of 16,208,000 tons, nearly double what it was ten years previously, and of this large total nearly one-third was consumed on the Indian railways, which again is an indication of the prosperous condition of the country as a whole. It is important to note, furthermore, that India has the benefit of cheap fuel, the price at the pit's mouth being only 4*s*. 8*d*., or but little more than half of what it is in this country.

The accident-death-rate for the five years under review shows unfortunately a considerable increase over the previous quinquennial period, namely, 1·38 lives lost per 1000 persons employed as against 0·98 per 1000; even the former figure is, however, lower than the average in Great Britain. On the other hand, the output of coal per person employed (below and above ground) shows a slight improvement, namely, 109·4 tons as against 98·6, this figure being about two-fifths of what it is in the United Kingdom. It must not be forgotten that a considerable amount of British coal is machine-cut, whereas coal-cutting machines make practically no headway in India on account of the relatively cheap native labour. It is interesting to note that two batteries of bye-product coke-ovens have at last been installed on the Giridih coal-field, capable of producing 40,000 tons of coke and 400 tons of sulphate of ammonia annually. It can only be hoped that further installations of such coke-ovens will be made, and that Indian agriculturists will learn to appreciate the value of sulphate of ammonia as a manure.

Amongst other items of interest may be noted the commencement of operations of the Tata Iron and Steel Co. at their Sakchi works, in consequence of which the production of iron ore in India jumped up by about 300,000 tons in 1911. The Barakar Iron Works also have replaced their former somewhat uncertain sources of iron ore supply by mines in the Manbhum and Singhbhum districts, and are now smelting about 96,000 tons of ore per annum.

Lead and silver appear for the first time in the table of mineral production, owing to the successful operations of the Burma Mines, Limited, at the ancient Bawdwin mines; the average annual production has been just about 9,000 tons of lead, carrying 80,000 ounces of silver, for the past five years.

Finally attention may be directed to the fact that various mines of the Salt Range have been found to contain in places a not inconsiderable proportion of potassium; some of the raw materials contain more than 11 per cent. of this element, and although its extraction presents some difficulties, the problem appears to be quite capable of solution. In view of the great demand

[1] "Records of the Geological Survey of India." Vol. xlvi. (1915.) Quinquennial Review of the Mineral Production of India. By Sir Thomas H. Holland and Dr. L. Leigh Fermor. Revised for the Years 1909 to 1913, by Dr. H. H. Hayden, Director, and Dr. L. Leigh Fermor, Superintendent, Geological Survey of India Pp. 296 and Index xlvi. Published by order of the Indian Government. Calcutta: Office of the Geological Survey of India; London: Messrs. Kegan Paul, Trench, Trübner & Co., 1915. Price two rupees.

that there is for potassium salts, and the urgency of finding fresh sources of supply, it cannot be doubted that this subject will receive all the attention that its importance deserves. It would indeed be fortunate if the needs of the British Empire in this respect could be supplied from our great Indian dependency. H. L.

PROF. H. DEBUS, F.R.S.

By the death of Dr. Heinrich Debus, which occurred at his residence in Cassel, Hessen, on December 9, we lose almost the last link which connects us with that notable group of men—Herbert Spencer, Darwin, Hooker, Huxley, Tyndall, Williamson, Frankland—who constituted the scientific hierarchy of London in mid-Victorian times. To the younger generation of British chemists, Debus was, probably, personally almost unknown, but up to within a few years ago he was a constant annual visitor to England, and was to be found at his former haunts in the Athenæum and Savile Clubs, or at the tables of such of his old friends as were left to him. But as the years passed the ties which led him to revisit the scenes of his social activities became fewer and fewer until there was scarcely a "kent face" left to him in his clubs or in the tea-room of the Royal Society, and London became nothing more to him than a place of dead friendships and departed memories, and so he ceased to come. A spare man, sharp-featured and clean-shaven, of abstemious habits, regular and methodical in his mode of life, and of a singularly placid and equable disposition, he maintained his mental and physical vigour up to an advanced age, and was able to take his daily walk almost to the last. His mortal illness was quite short, and he passed away peacefully during the night of December 9, in the ninety-second year of his age.

Debus belonged to a school of chemists of which scarcely a representative remains. A reticent man, and particularly uncommunicative concerning his personal affairs, very little is known of his origin or early history beyond that he was the son of Valentine Debus, and was born in Hessen in July, 1824. His earliest instructor in chemistry was Bunsen, who succeeded Wöhler at the Polytechnic School of Cassel in 1836, and where he remained until 1839, when he was appointed Professor Extraordinarius at Marburg. Debus followed him from Cassel and graduated at Marburg in 1848. Here he formed the acquaintance of Kolbe, and gained the friendship of Frankland, a circumstance which materially affected his subsequent career, as it led to his coming to England, and his eventual selection as Professor of Chemistry in the Royal Naval College, Greenwich. In Frankland's slight autobiographical sketch, the publication of which we owe to the pious care of his daughters, we read that Debus established a "record" at Marburg, inasmuch as he was the first in that university to hold the "disputation" in German instead of in Latin. What "wrangling" then meant in a German university may be gathered from the following extract from Frankland's journal, under date November 4, 1848, relative to this event:—

I heard Debus read his discourse and dispute in the University, after which he was fully invested with the title of Ph.D. The Pro-Rector and six professors were present, most of whom, as well as two doctors whom Debus had brought with him, disputed the following theses:—(1) The allotropic condition of matter depends upon differences in the arrangement of atoms; (2) the ferrocyanide compounds are not to be considered as double salts; (3) the opinion of Ettingshausen as to the cause of electrical phenomena is untenable; (4) the unequal heating of the air and the earth is the immediate cause of the greater part of atmospheric electricity; (5) the organic bases are coupled ammonia compounds; (6) the doctrine of polymeric isomorphism is erroneous.[1] The ceremony of installation lasted above an hour and a half, and at its close Prof. Bunsen delivered an oration on the volcanic phenomena of Iceland.

Frankland, it may be noted in passing, established a further "record" by being the first Englishman to graduate in Marburg; on this occasion the Faculty dispensed with the disputation in the Aula altogether, on the ground, as he says, that being a foreigner, he had not sufficient command of the language, either Latin or German.

Debus's earliest published scientific work, in 1848, was probably inspired by Kolbe, who, after a short sojourn in England, had rejoined Bunsen at Marburg. It consisted of a short paper on the chemistry of madder root, in which the author failed to recognise the nature and mutual relations of alizarin and purpurin; these he termed, respectively, "lizaric acid" and "oxilizaric acid." His next essays were more fortunate, and he published in rapid succession a number of papers on organic sulphur products, and on the oxidation products of alcohol, glycerin, and glycol. His work on glycerinic acid and its salts, on glyoxal, and glyoxylic acid, finds its due place in the chemical history of these substances. Among subsequent papers the most noteworthy are "On the Chemical Theory of Gunpowder," "On the Nature of Wackenroder's Solution," and his controversy with the late Sir Henry Roscoe on the origin of Dalton's atomic theory.

Debus came to this country in 1851, and, like his friend Frankland, was at first engaged in school-teaching, first at Queenwood College and then at Clifton. In 1870 he moved to London, and was attached to the medical school of Guy's Hospital as lecturer on chemistry. On the establishment of the Royal Naval College at Greenwich he was appointed Professor of Chemistry, presumably through the action of his friend Hirst, who was made Director of Studies. Here he remained until the age of retirement compelled him to relinquish the duties of his chair, when he gave up his London residence and again settled in Germany.

Debus joined the Chemical Society in 1859, and was a vice-president in 1871–4, but took little share in the management of the society. He was

[1] In the original the titles of the theses are given in German.

elected into the Royal Society in 1861, and served on the Council in 1870–72, and again in 1881–83. He was a well-read, scholarly man, of sound judgment, and a shrewd judge of character. He was never married, but was very fond of children, with whom he was very popular, in spite of certain peculiarities of manner and speech and little affectations of dress—such as a passion for coloured ties—amiable weaknesses which only served to endear him still more strongly to his many friends. He was an excellent teacher, with a quiet dignity of manner, and a subtle appreciation of humour, with a skill in parrying its shafts, which effectively checked the efforts of the potential Ben Allens and Bob Sawyers at Guy's, or the too exuberant spirits of the young lieutenants of H.M.S. *President* at Greenwich. He served for three periods—in all fifteen years—as an examiner in chemistry of the University of London in the old Burlington Gardens days. His sympathy with young men, and his quick discernment of character and merit, together with his experience as a teacher and his wide knowledge of his subject, were excellent qualifications for the position, and he enjoyed the fullest confidence of his colleagues at the famous round-table in the old university buildings. T. E. T.

NOTES.

WE notice the names of three fellows of the Royal Society, all of whom are engaged in Government departments, in the list of New Year honours, namely, Dr. Lazarus Fletcher, director of the Natural History Departments of the British Museum, who has been knighted; Col. H. C. L. Holden, assistant director of supplies and transport, War Office, who has been promoted to the rank of K.C.B.; and Sir W. Watson Cheyne, who has received the honour of K.C.M.G. We do not recognise in the list any names of men specifically selected for honours on account of their productive work in scientific fields, but the following may be appropriately recorded here because of their association with such work:—*Knights*: Dr. Adam Smith, principal and vice-chancellor of Aberdeen University; Dr. G. A. Berry, honorary surgeon-oculist to the King in Scotland, and formerly president of the Royal College of Surgeons, Edinburgh; Dr. T. W. Parkinson, author of works on cancer and tumour; Mr. M. Rees, laryngologist to the King's Household and to Queen Alexandra. *K.C.M.G.*: Sir James Porter, honorary physician to the King. *K.C.V.O.*: Sir A. A. Bowlby, surgeon in ordinary to the King. *C.M.G.*: Dr. J. Cadman, professor of mining in the University of Birmingham. *C.B.*: Col. C. P. Martel, superintendent, Royal Gun and Carriage Factory, Woolwich Arsenal; Mr. A. W. J. MacFadden, Chief Inspector of Foods, Local Government Board.

IN reply to questions asked by Mr. Lynch in the House of Commons on January 4, Mr. Asquith said that every endeavour continues to be made to organise and utilise all the available scientific ability of the country in the most efficient way with the view of coping with problems introduced by the war. The activities of the scientific committees have been by no means limited to criticism and advice with regard to suggestions and inventions sent in from outside. Mr. Asquith also said that a body of scientific workers is definitely charged with the study of actual war conditions, that is, to examine, devise, or invent appliances which may be helpful to the Allies in the field.

THE Government of British Columbia has presented to the Royal Botanic Gardens, Kew, a magnificent spar of Douglas fir to replace the old flagstaff which was taken down in 1913 owing to decay. The suggestion to present a really fine specimen of a Douglas spar was made by Mr. J. H. Turner, the late Agent-General for British Columbia, and was readily taken up by the Premier and the Government of British Columbia. This suggestion, made in the autumn of 1913, has now definitely materialised, and the spar, which was loaded on to the R.M.S. *Merionethshire* in August, 1915, arrived in the Thames at the close of last year, and was moored in the river off Kew Gardens on January 3. The spar was logged from the lower mainland coast of British Columbia. The tree selected measured 220 ft. in length, 6 ft. in diameter at the large end, and 18 in. in diameter at the small end. The log was loaded on a logging railway and hauled ten miles to salt water, being taken by a tug to Vancouver. There it was hewn to its final shape, making it 215 ft. in length, 33 in. at the butt, and 12 in. at the top. Its weight is about 18 tons. The spar was brought from British Columbia on the deck of the *Merionethshire*, and its loading was accomplished with some difficulty. Its erection in the Royal Botanic Gardens will be an operation of considerable magnitude.

WE much regret to note the death of Dr. George Oliver, of Riversleigh, Farnham. He was a man of very great ability and extraordinary energy. Although for thirty-five years he was engaged in a very large and exacting practice at Harrogate, he yet found time to make most valuable researches on the circulation of the blood. He was one of the first to take up the question of the pressure of blood in the arteries, and the instrument he invented for the purpose of measuring the arterial tension in man was only surpassed in ingenuity by his arteriometer for measuring the actual diameter of the artery. He also invented an ingenious instrument for measuring the amount of hæmoglobin in the blood. With these instruments he made many important observations, which he embodied in two works, "Blood and Blood Pressure" and "Studies in Blood Pressure," works which were both of scientific interest and practical value in treatment. Along with Sir Edward Schäfer he examined the action of the extract of suprarenal glands and proved it to be simply enormous. This observation is one of fundamental importance in regard to the physiological problem of how the blood pressure in the living body is maintained in equilibrium. Dr. Oliver was a gold medallist of the University of London, and Croonian lecturer in 1896 at the Royal College of Physicians, of which he was a fellow. He established the Oliver-Sharpey lectureship at the Royal College of Physicians in memory of his old teacher, Prof. William Sharpey,

and he gave a course of these lectures himself in 1904. To those who knew the amount and value of Dr. Oliver's work, it was a constant source of wonder why he was not elected to a fellowship of the Royal Society. His death is a great loss to medicine, for although he was seventy-four years of age he was still active and energetic.

WE announce with regret the death, at Kilmarnock, on December 26, 1915, of Mr. A. D. Darbishire, lecturer on genetics in the University of Edinburgh, and known by his experiments bearing on the laws of heredity, and his book on "Breeding and the Mendelian Discovery." While at Oxford Mr. Darbishire came under the influence of the late Prof. Weldon, and he took up and carried on Prof. Weldon's researches on the inheritance of colour in mice—researches which were designed to test the continuous character of variations in colour, and to prove the untenability of the idea of the clear-cut, sharply distinguishable mutations postulated by Mendel and his followers. A floor case in the Natural History Museum, containing a score of mice of various colours, shows in a most instructive way the practical meaning of the results obtained by him in breeding. After his graduation, Mr. Darbishire became demonstrator of zoology in the University of Manchester, and pursued his investigations there, and gradually he became convinced of the general soundness of the Mendelian position. In 1905 he was appointed demonstrator of zoology in the Royal College of Science (afterwards incorporated in the Imperial College of Science), which post he held until 1911, when he was appointed lecturer on genetics in the zoological department of the University of Edinburgh. Mr. Darbishire endeared himself to all who came into contact with him; his personal charm was really irresistible. During the summer of 1914 he gave a course of lectures on heredity at the Graduate School held biennially in different centres under the auspices of the U.S. Department of Agriculture. Upon reaching home after the outbreak of the war he offered his services as a munitions worker, and spent some months in arduous training for this work. Later, though conscious of the fact that he was really unfit for service in the ranks, he enlisted as a private in the Argyll and Sutherland Highlanders. His appointment to a commission in the Royal Garrison Artillery was published three days after his untimely death, which has deprived British science of a brilliant follower devoted to sound research.

THE death is announced, at Cambridge, Mass., of Mr. C. A. R. Lundin, who won distinction with the firm of Messrs. Alvan Clark and Sons in the construction of many of the largest telescope lenses in the world. He was born in Sweden in 1851, and went to America in 1874, when he became associated with Messrs. Clark. Among the telescope objectives upon which he was engaged are the 30-in. objective for Pulkowa Observatory, the 36-in. lens of the Lick Observatory, the 40-in. lens of the Yerkes Observatory, the 16-in. lens of the University of Cincinnati, and the 18-in. lens of Amherst College. He had also devised and put into operation several important optical tests.

WITH the death last week of Mr. H. A. Taylor, at the age of seventy-four, there has passed away a distinguished pioneer in the development of electrical science, who was chiefly identified with most of the submarine cable enterprises undertaken within the last forty-five years. A mathematician and physicist of a high order, he was associated with the late Latimer Clark in a number of electrical researches in connection with the electromotive force of the standard cell, the effect of temperature on the electrical resistance of gutta-percha, etc. The Clark cell, if carefully used, will remain constant for years, but it polarises quickly, and is generally only used for those tests in which the batteries are tested when they are not sending any current at all, but simply maintaining a potential difference. Taylor was associated with Dr. Muirhead in the development of a system of duplexing submarine cables, which is a modification of the bridge method, and has proved remarkably successful, many important cables, such as those of the Eastern Telegraph Co. and the various Atlantic cables being worked on this plan. The introduction of automatic transmission for cable circuits was also in a large measure due to him.

FROM Würzburg comes the news of the death there on December 2, 1915, of Dr. Fritz Regel, the professor of geography and director of the Geographical Seminar at the University. Regel was born on January 17, 1853; and his first teaching work was done at the Stoy Institute, in Jena. In 1892 he was given the first full chair in geography at the Jena University, where he taught until 1908, when he moved to Würzburg. His skill as a teacher of geography was renowned; no less so was his fame as a writer. He was one of the best authorities on his own native district, Thuringia, about which he wrote the "Landeskunde" (fourth edition in 1913), and a "Handbuch" in three volumes. But he also had more than a passing knowledge of other portions of the globe, as his various books testify—"Kolumbien" (1899), "Die Nord- und die Südpolforschung" (1905), "Der Panamakanal" (1908), his admirable survey of South America (1910), and his description of western, northern, and eastern Europe (1909), the second and first volume respectively of the "Geographisches Handbuch"; and last, but by no means least, his "Landeskunde der Iberischen Halbinsel" (1905), based on travels in Spain.

DR. C. F. HOLDER, who died in October last, was a good type of the open-air naturalist, who combined in a somewhat unusual way a love of sport with a devotion to the cause of wild-life protection. He was born in 1851 in Massachusetts, of Quaker stock, and was devoted to natural history from boyhood. His early work was as a curator in the American Museum of Natural History in New York City, but considerations of health led him in 1885 to Pasadena, in southern California, where he spent the rest of his life, observing and fishing and writing. He was a good citizen of a notably beautiful city, and took a great interest in local educational affairs. Shortly before his death he was appointed honorary professor of zoology in the Throop College, the foundation of the chair being due to a lifelong friend, Dr. George E.

Hale, director of Mount Wilson Observatory. Among Dr. Holder's numerous popular books may be mentioned:—"Living Lights" (1887), a picturesque and concrete account of phosphorescent animals and plants, his interesting lives of Louis Agassiz and of Charles Darwin, besides "Along the Florida Reef" (1892), "Stories of Animal Life" (1900), "Half-Hours with Nature" (1901), "The Log of a Sea Angler," and "Life in the Open in Southern California." He was tireless in his endeavours to infuse into others his own enthusiasm for natural history, to broaden the interests of the sportsman, and to strengthen the hands of Audubon societies and similar leagues which have for their object the conservation of the wild life of both land and sea.

THE *Times* of December 30 publishes the following note from its Huddersfield correspondent:—Good progress is being made in carrying the British Dyes (Limited) scheme into effect. With more than 3000 workmen, the contractors, Messrs. McAlpine, are pushing forward the erection of the works, which will form the main portion of the scheme. The chief hindrances are the scarcity of labour and of raw materials for the manufacture of colours. Exceptionally high rates of wages are being offered for men, from ordinary navvies to skilled artisans and chemical workers. Many hundreds of men drawn from other occupations have become chemical workers and are making more money than ever they earned before. As for raw materials, British Dyes (Limited) are obtaining a preference in regard to supplies, and the output is steadily increasing. While the demand cannot yet be fully met, it is officially stated that within another month the supply will be much more adequate.

THE report of the council of the Scottish Meteorological Society, read at the general meeting of the society on December 21, shows that during the past year the more purely routine work of the society has proceeded much on the usual lines, though difficulties inseparable from war conditions have arisen, and at one or two stations it has been found impossible to continue a full set of observations. At most of the stations in Scotland the work is in the hands of voluntary observers, and the closer connection that now exists between Edinburgh and the Meteorological Office in London has in no way weakened the almost family loyalty that linked the observers to the society. Indeed, the extended publicity now available for trustworthy observations through the medium of the Monthly Weather Report has been greatly appreciated by the observers. During recent years the society has devoted much attention to the encouragement of the observation of rainfall in Scotland, and there are now available in the Journal monthly and annual figures for more than 700 stations. An improvement has taken place in the representation of the upper part of the Spey valley; but there are still large areas in the Highlands and north of Scotland for which no information is available. Prof. R. A. Sampson, Astronomer Royal for Scotland, has been elected president of the society for the ensuing twelve months, and Mr. C. T. R. Wilson, University lecturer in physics, Cambridge, and Dr. A. Crichton Mitchell, Edinburgh, vice-presidents.

WE have received the annual report of Livingstone College for the year 1914–15. We have on several occasions directed attention to the work of this college, which is to give an elementary training in medicine to missionaries. The college as such is closed for the present, as it is being used as a hospital for convalescent wounded soldiers.

A FIRST report of the Special Investigation Committee of the Medical Research Committee upon the incidence of phthisis in relation to occupations has recently been issued, and deals with the boot and shoe industry. The conclusions arrived at are: (1) that phthisis is specially prevalent among workers in the boot and shoe industry, as compared with the general population; (2) the individual worker is predisposed to infection by the sedentary nature of his employment, and possibly by the attitude he adopts at his work; (3) the infection is probably (*a*) increased by the number of infective workers, and (*b*) favoured by want of light, the presence of infected dust, and inadequate ventilation in the workrooms. The measures suggested to diminish the incidence of phthisis among this class of operatives are improvement of lighting, floor cleaning, and ventilation in the factories, and the introduction of periods of rest and exercise for the workers. A modified scheme of sanatorium treatment for the affected is also outlined.

WE commend to our readers the admirable article by Prof. Fraser Harris in the *Scientific Monthly*, October, 1915, on "Edward Jenner and Vaccination." Prof. Fraser Harris gives us a short historical sketch of the earlier ages of smallpox in Europe; the old story, how disease, like trade, "follows the flag"—follows, *pede aequo*, the crescent and the cross. Then an account of the discovery of inoculation: a method of great antiquity, used far and wide among "savages," let alone the Turks, who taught it to Lady Mary Wortley Montagu. Then a careful description of the rise and development of Jenner's work, and a sufficient notice of the objections raised against it. Especially, he answers well the stock objection, that not Jenner but "sanitation" saved us from the scourge of smallpox. Perhaps, in years to come, men of science will discover some method of personal immunity even better than vaccination; some "vaccine" made without the intermediary calf. If or when they do make that discovery, they will make it on the direct lines of the work which Jenner began and Pasteur advanced. In that day, let us hope, the nation will put Jenner's statue back in Trafalgar Square. If there is no room for it, they can move King George IV. to the vacant pedestal in Kensington Gardens.

THE small South American deer known as "Brockets" will furnish some useful data to those who are interested in the study of incipient and variable characters, and the bearing which these have on the evolution of species. This much will be apparent to all who read Mr. J. A. Allen's valuable "Notes on American Deer of the Genus Mazama," in the Bulletin of the American Museum of Natural History, vol. xxxiv. Broadly separable, on the basis of coloration, into two groups, in the matter of their antlers, which are but simple spikes, no

diagnostic characters can be found. These weapons indeed are very variable, even in adults of the same species, and should perhaps be regarded as disintegrating structures, since in both groups they display a marked tendency to malformation. In regard to cranial characters, it is evident that, as the author points out, the relative size and form of the nasals, the size and contour of the antorbital vacuity, the junction or otherwise of the premaxillaries and nasals, and the depth of the lachrymal pit are extremely untrustworthy as diagnostic characters, although they often enter into the diagnoses of species and subspecies.

SOME valuable notes on the fauna and flora of the Vedda country and on the Vedda people, by Mr. F. Lewis, appear in *Spolia Zeylandica* (vol. x., part 37). The area surveyed includes part of the eastern and part of the Uva provinces, and is inhabited to-day by people of mixed origin, mainly Sinhalese and Tamils. Pure Veddas are practically extinct. The survivors of this primitive race exhibit a great reluctance to speak in the Vedda language in the presence of Europeans; nor are they more communicative in regard to the manners and customs of their race. Nevertheless, Mr. Lewis contrived to gain some valuable information when at Selavai, in the Panapa Pattu. From one old man he learned that the Veddas, in the days of their prosperity, were divided into a number of small clans, each of which occupied and hunted over a specific area of country, and had no connection with the others, who lived in separate communities. The women were kept in a state of rigid subjection, married as children, became mothers at fourteen, and passed the prime of life at thirty. These people had no domesticated animals save the dog, and their only weapons were the bow and arrow, the spear, and a small axe or hatchet. At one time, it appears, they were harassed by a pigmy people, the Nittawo, who lived in the country known as Lenama, which extended from Bagura, in the east, to the confines of the Kataragama hills on the west. These diminutive people lived in small troops, and inhabited caves, hollow trees, and the crevices of precipices. In stature they are said scarcely to have exceeded 3 ft. Through fear, or jealousy, they are said to have been exterminated about three or four generations ago by the Veddas themselves.

In the *Annot. Zoolog. Japan*, ix., part 1 (Tokio, 1915), Waro Nakahara describes the Japanese lace-wing flies of the subfamily Hemerobiinæ. Of the twenty-two species enumerated, three only are inhabitants also of Europe, and of these, two—*Hemerobius humuli* and *Micromus angulatus*—are also North American.

ABNORMALITIES in the venous system of the frog are more or less familiar to teachers in zoological laboratories. W. E. Collinge gives (*Journ. Anat. and Physiol.*, l., pp. 37–42) some results from the dissection of five hundred specimens, of which twenty-two were in some respect abnormal. Of especial interest are the persistence of the caudal vein, of the right posterior cardinal sinus, and of the anterior abdominal vein's connection with the precavals on one side or both; also the continuity of a renal portal vein with the post-caval.

PROF. NANSEN describes the details of construction of two closing tow-nets in *Publications de Circonstance*, No. 67, issued by the International Council for the Study of the Sea. The first net is the well-known form devised by Prof. Nansen for vertical hauls, which had not previously been described in detail. The second net is a modification of the first, adapted for horizontal towing. A current meter fitted in the mouth of the net is stated to make it possible to measure the volume of water which actually passes through the net.

THE twenty-first volume of the *Rapports et Procès-verbaux des Réunions* of the International Council for the Study of the Sea, recently issued at Copenhagen, contains the administrative reports for the years 1913 and 1914, and its chief interest perhaps lies in the fact that it records the attempt which is being made to keep this international organisation in existence during the period of the European war. The report states that as regards participation for the year 1914–15, all countries except Germany have paid contributions, that for Russia, however, being an overdue contribution for the preceding year. In a letter of January 29, 1915, to the Danish Foreign Office, the German Government has explained its attitude in the following terms:—"Germany will during the war abstain from further co-operation in the work of the international investigations, because the carrying out of an essential part of the problems has been suspended by the present state of matters. Consequently the German delegates will not take part in the voting and resolutions of the organisation as long as war continues. The Imperial Government, however, hope to be able to resume participation when a more quiet time has ensued." As regards the scientific reports contained in the volume, those of importance deal with the investigations on herring fisheries.

MR. L. LANCELOT BURLINGAME has published a series of memoirs on *Araucaria brasiliensis* and on the origin and relationships of the Araucarians in the *Botanical Gazette*, vol. lvii., No. 6, vol. lix., No. 1, and vol. lx., Nos. 1 and 2 (1914–15). His researches embrace a careful study of the ovulate cone and female gametophyte, fertilisation, the development of the embryo and the seed, illustrated by a series of plates of microphotographs. In the two latter papers the various views of Araucarian affinities are reviewed, and the conclusion is arrived at that the Cordaitales are the nearest allies of the Araucarias, since they resemble them more nearly than any other conifers. The transitional conifers of the Mesozic are either Araucarians or Cordaitians, and it is suggested that some are ancestors of Sequoia and Cryptomeria. It is also suggested that the Abietineæ are derived directly from the Cordaitales or from very ancient members of the Araucarineæ.

IN the cutivation of varieties of wheat, mixtures of types sometimes occur on the pure-culture plots, which are often very difficult to explain. In vol. x., part iv., of the Agricultural Journal of India, Mr. D. Milne

shows that whole wheat grains fed to the bullocks working in the wheat fields in the growing season can pass through the animals, germinate, and thus account for some of these contaminations of the pure cultures. Six bullocks were fed on a special diet of whole wheat grains previously soaked for one hour in cold water. A mixture of green oat plants and wheat chaff was also given as fodder during the experiment. All the wheat grains voided by the animals were carefully collected, and at once placed on a bed of sterilised sand for germination tests. A considerable number of wheat grains capable of producing strong plants were taken from the dung of every bullock within 13½ hours from the start of the experiment. On the third day the number of grains passed by one bullock in 24 hours rose to more than 9000. After seven days the diet of whole wheat grains was replaced by whole gram grains, yet for two days after this change large numbers of wheat grains capable of germination continued to pass through the animals. As much as 20·5 per cent. of the grains fed to a single bullock were recovered, germinated, and produced strong healthy plants; the lowest figure from a single bullock was 9·6 per cent. The gram grains fed during the last four days of the experiment also passed through in quantity, apparently undigested, but practically none of these gram grains germinated. The author thinks that the amount of obviously undigested material which came through these bullocks was astonishing, but, in this country at any rate, farmers well know the superior digestibility of crushed or ground grain, so that the investigation suggested on this point would appear to be unnecessary.

FROM an American source (Bull. Seis. Soc. America, vol. v., 1915, pp. 155–9), we learn that several earthquakes were felt during last summer in countries now at war. On June 3 an earthquake occurred at Munich of sufficient violence to wreck some of the instruments in the observatory tower. On June 13 a severe earthquake disturbed the kingdom of Württemberg, being especially strong at Ebingen and Balingen. On August 11, at 10.14 a.m., a shock of unusual severity was felt at Laibach, the well-known seismic centre in the south of Austria. In the same journal, the occurrence is reported of several earthquakes at Avezzano on August 28, of a severe shock at Agualia (fifty-eight miles north-east of Rome) on September 23 at 7.15 p.m., felt also in Rome, and of a strong shock unaccompanied by damage, at Messina, on September 24.

Two articles by M. Louis Brunet, in the *Revue générale des Sciences* for November 30 and December 15, contain in about twenty pages a very complete and readable summary of the recent work which has been done on the constitution of Röntgen or X-rays, and their application to the determination of the arrangement of the atoms in crystalline bodies. The first article deals with the interference of rays reflected from the successive layers of atoms near the surface of a crystal, the forms of X-ray spectrometers, the characteristic X-ray spectra of the elements and the relations which have been found to exist between the wave-lengths of the principal lines of each element and the atomic numbers. According to Rutherford's theory of the atom, these represent the number of electrons in the nuclear charge of each atom. The second part deals more in detail with the passage of the X-rays through and their reflection from the surfaces of crystals. The principles of the method of analysis of the structure of a crystal as described by Bragg are given, and the application of them illustrated by zinc blend, diamond, calcite, certain nitrates and carbonates, and iron pyrites.

THE Comptroller-General of Patents informs us that the following notice as to renumbering specifications on publication will appear in the *Illustrated Official Journal* (*Patents*) of January 12:—In order to give the public the advantage of having abridgments of specifications up to date while retaining their numerical sequence, applications for patents made subsequent to 1915 will be given new numbers when their complete specifications are accepted or become open to public inspection before acceptance. The new numbers will start with No. 100,001 (without any indication of date), and will supersede the original application numbers in all proceedings after acceptance of the complete specifications. It is intended in future to issue abridgments of specifications in the journal a few weeks later than that in which their acceptance or publication is advertised, so that they will be available for search purposes soon after the printed copies of the specifications are on sale; but, until the system is fully in force, they will only be issued when there are sufficient to make up a full sheet of sixteen pages.

THE list of members just issued by the Liverpool Section of the Society of Chemical Industry calls for comment as a most praiseworthy beginning for the preparation of what amounts to a local "Who's Who" of chemists. Such a list will form a most useful asset in any attempt to organise the chemical profession to play a greater part in the affairs of the State. The Liverpool Section includes all members of the society residing or working in Lancashire, Cheshire, and North Wales, who are nearer of access to Liverpool than to Manchester—in all 283, a number which suggests that many chemists in the district have failed to become members of the society. The list is printed in four columns, and indicates for each individual the address, occupation, and name of the firm. A pleasing feature is the evidence afforded of the number of chemists employed by some of the leading manufacturers in the district.

STEADY progress has been made with the building of the new Southwark Bridge, although the war has hindered the delivery of materials. The work of constructing one of the river piers is described in *Engineering* for December 31. There are four of these piers, the new bridge being of five spans, instead of three, in order to coincide with the bridges to the east and west. The piers are all to be carried upon caissons founded in the London clay at a depth of 50 ft. below the Trinity high-water level. Two of the four caissons required for the river piers are 120 ft. long by 30 ft. wide, and the other two are 100 ft. 3 in. by 29 ft., the weight of each of the larger caissons being 200 tons; these are the longest caissons constructed in this country. At the present time two of the caissons have been lowered to the bed of the river,

and a third is erected and riveted complete upon its staging. In lowering the caisson, excavation within the working-chamber proceeded until a point was approached about 5 ft. from foundation level; at this point the clay at each end of the chamber was not removed, but allowed to come in contact with the descending roof of the chamber for a length of about 12 ft. from each end. The weight of the caisson, together with the concrete and masonry, approximated to 5000 tons, but there was full control of the movements, and the downward travel was stopped easily at the given level.

THE *Athenaeum* will in future continue its issue only as a monthly, and not weekly as heretofore. The new number will be published on January 15, at the price of a shilling.

THE Cambridge University Press announces the forthcoming publication of vol. ii. of Dr. W. Ridgeway's "The Early Age of Greece," and a new edition of vol. i. of the work. The following "Cambridge Tracts in Mathematics and Mathematical Physics" are in preparation:—"The Definite Integral, its Meaning and Fundamental Properties," by Dr. E. W. Hobson; "An Introduction to the Theory of Attractions," by Dr. T. J. I'A. Bromwich; "Pascal's Hexagon," by H. W. Richmond; "Lemniscate Functions," by Dr. G. B. Mathews; "Chapters on Algebraical Geometry," by Prof. H. F. Baker; and "The Integrals of Algebraic Functions," by Prof. H. F. Baker.

OUR ASTRONOMICAL COLUMN.

COMET 1915*e* (TAYLOR).—Several communications to the Paris Academy of Sciences (*Comptes rendus*, December 20) concern Taylor's comet. At the Lyons Observatory M. J. Guillaume obtained a brief observation of the comet on December 6. A feeble nucleus was seen surrounded by a nebulosity about 1′ in diameter. Its magnitude was 9·5 and the colour was bluish. Positions were measured on December 11 and 13, the comet fading to 10·5 mag. M. Paul Brück has calculated the following orbit from observations made at Algiers (December 6), Lyons (December 11), and by himself at Besançon on December 14:—

Perihelion passage, 1916, February 26·986.

$$\left.\begin{aligned}\omega &= 14^\circ\ 13'\ 46''\\ \Omega &= 107^\circ\ 16'\ 10''\\ i &= 22^\circ\ 44'\ 23''\end{aligned}\right\}1915\cdot0$$

$$\log q = 0\cdot22625$$

This parabolic orbit represents the middle place with an error of $-9''$ in longitude and $-32''$ in latitude, and a second calculation is to be made. With the first ephemeris sent out from Copenhagen Prof. E. Strömgren stated that the orbit was apparently periodic in short period. In Circular No. 497 (*Astronomische Nachrichten*) Prof. H. Kobold directs attention to the similarity between Messrs. Braae and Fischer-Petersen's second orbit (NATURE, December 23, 1915) and Lamp's elements for Brorsen's comet $\omega = 14^\circ\ 55\cdot6'$, $\Omega = 101^\circ\ 27\cdot6'$, $i = 29^\circ\ 23\cdot8'$ (1890).

An observation made at the Hill Observatory on January 1 indicates an increasing lag between the comet's actual position and that calculated from the above orbit, then amounting to about 30′ of arc in both R.A. and declination. The comet, easily seen in a three-inch finder, had evidently increased in brightness by about 2½ magnitudes since December 16.

THE SPECTRA OF WOLF-RAYET STARS.—A most significant clue to the relationships of these extremely interesting stellar bodies was afforded by an extraordinary piece of spectroscopic research carried out at Mount Wilson upon the faint vestiges of several novæ. It was then practically established that in their latest phases these bodies assume the well-known Wolf-Rayet features. Hartmann's observations of Nova Persei were confirmed and generalised. The suggestion was made that the Wolf-Rayet stars were possibly remnants of novæ. Extremely important evidence bearing on this point has now been brought forward by Dr. Max Wolf (*Astronomische Nachrichten*, 4824). He finds that in the case of several of these stars the spectra are variable in the oscillatory mode hitherto regarded as peculiar to the later stages of novæ. The variations are described as alterations in the hydrogen bands, especially Hδ, whilst the absorption lines are said to appear at times sharp, at others masked and weakened. As Dr. Max Wolf refers to the limitations of his instrumental equipment, developments must be looked for elsewhere. A photometric study of the same stars would most obviously be of great value.

PHOTO-ELECTRIC PHOTOMETRY.—Messrs. P. Guthnick and R. Prager announce (*Astronomische Nachrichten*, 4823) that the conjectured variability of α Cygni has been confirmed by numerous photo-electric measures. Minima were found, 1914, September 28 ±10*d*, and 1915, July 5, ±10*d*, the interval being a multiple of the period. Amplitude 0·07 mag., probably in the mode of δ Cephei. Short period oscillations are indicated. The variability of α Lyræ and γ Lyræ has also been evidenced. The light changes in both cases are described as very rapid and strictly periodic for the latter. α Lyræ, however, would seem to vary in a novel manner, with an average amplitude of 0·04 mag., γ Lyræ 0·03 mag.

SOME POSSIBLY CONNECTED SOLAR AND PLANETARY PHENOMENA.—An attempt has lately been made by Herr T. Köhl to trace a connection between some planetary phenomena and solar activity (*Astronomische Nachrichten*, 4821). Thus he finds that Jupiter's northern cloud belts appear to be especially weak at times of spot maxima, and become broader and more conspicuous during minima. The recorded appearances of the secondary light on the dark side of Venus are too scanty for comparison, but the later observations suggest coincidence in time with auroral displays on earth.

DETERMINATION OF RADIAL VELOCITIES BY OBJECTIVE PRISMS.—Nearly two years ago M. Hamy suggested an ingenious method of adapting the prismatic camera to line of sight work (NATURE, vol. xcii., p. 616, January 29, 1914). Whilst the determination of radial velocities of the fainter stars is actually largely in way of being realised by increased telescopic power and suitable spectrograph design rather than by the employment of novel methods of attack, M. Hamy has not been deterred from investigating further the theory of his method. He now states (*Comptes rendus*, No. 22, 1915) that the use of a train of prisms would only necessitate a modification of the reduction formulæ, and then develops the requisite changes for the case of an instrument mounting two prisms.

RADIAL VELOCITY OF R CORONÆ BOREALIS.—Dr. H. Ludendorff, in a note in the *Astronomische Nachrichten* (No. 4823), publishes the results of some spectroscopic observations of R Coronæ. Six spectrograms were secured during June, 1913, and June, 1915, whilst the variable was at normal brightness, as was the case during earlier observations in 1902–1906. The spectrum resembles that of α Persei, and no signs of alteration could be detected. The mean radial velocity for the six plates is +24·8 km. (range=5 km.). The earlier measures gave +24·7 (range=6·4). The small range, under the conditions, leaves undecided the question of variability.

MODERN SYSTEMS OF INDEPENDENT LIGHTING AND HEATING.

(1) *Oil, Oil Gas, and Petrol-air Gas Systems.*

UNTIL quite a late period in the nineteenth century country houses were invariably lighted either by candles or oil lamps. To-day there are at our disposal many different systems of lighting, suited respectively to the cottage and the mansion.

For small houses in remote districts there is still a good deal to be said for the paraffin or petroleum lamp, provided a well-constructed and trustworthy type is employed, and the oil used is of a good standard quality. At the present time lamps giving as much as 100 candle-power can be obtained, and in favourable circumstances 300–500 candle-power hours, or even more, can be obtained per gallon of oil. The fact that the oil lamp is entirely self-contained and can readily be moved from place to place is naturally an advantage, and the low intrinsic brilliancy of the flame and the mellow colour of the light are considered pleasing by many people.

FIG. 1.—"Petrolite" lamp using upright incandescent mantle fed by air which has passed through porous material impregnated with volatile hydrocarbons.

The type of shade used with the oil lamp is of some importance. The vertical shallow tin reflectors attached to cheap forms of paraffin lamps are not very satisfactory. Such lamps are sometimes hung on the walls, throwing out the light into the room indiscriminately and giving a somewhat glaring effect. It is preferable to use some form of diffusing glass shade completely screening the light from the eyes and directing the rays downward to the table. The oil lamp is probably at its best when equipped with such a shade, and used in a central position in the room, or immediately above the surface it is intended to illuminate.

The introduction of incandescent oil lamps (*i.e.* lamps using oil or paraffin vapour with an incandescent mantle) led to a great increase in efficiency. There are now many such lamps on the market. For example, the Petrolite lamp, in which air is sucked through a porous material impregnated with suitable hydrocarbons, a draught being secured by using an exceptionally long chimney. The lamp is claimed to be exceptionally safe, as it goes out at once if accidentally upset. According to some recent tests a light of 40 candles can be obtained by burning 1½ oz. of hydrocarbon per hour.

The incandescent oil system, however, gives the most efficient results when used for relatively powerful lighting units. A well-known type is the Blanchard lamp, using paraffin vapour, with an inverted mantle. These lamps range in illuminating power from 100 to 1500 candles, and are claimed to give more than 10,000 candle-hours per gallon of oil. Their use is very simple, and the evolution of vapour can be easily started with a little spirit. Amongst other lamps of this type we may mention the Kitson, Still, and Petromax lamps, all of which are capable of giving a high candle-power, and are particularly useful for lighting large rooms, country halls, yards, etc., or for fêtes and garden parties.

The illuminants mentioned above are all self-contained and portable, and are cheap and simple in operation. On the other hand, they naturally require a little attention, so that in larger residences the trouble involved in looking after a large number of lamps in different rooms is worth consideration. Hence there has sprung up a demand for a distributing system, similar to gas and electricity, and available in localities where these methods of lighting are not available. The "petrol-air gas plants," of which there are now a number of types on the market, were designed to satisfy this need.

Petrol-air gas consists simply of air to which has been added a small percentage of petrol vapour. Such a mixture is very easily produced owing to the volatile nature of petrol, and can be generated by a small automatic plant, conveniently kept in a small outhouse. The mixture generated is then led into the house through pipes and distributed to incandescent

FIG. 2.—Types of small candle-power portable Blanchard incandescent oil lamps. With this system units from 100 to 1500 c.p. can be obtained.

burners in the same way as coal-gas. (This gas can only be used with mantles, and is not suitable for burning in flat flame burners.) The percentage of petrol employed is invariably small (2–6 per cent., according to the system). The gas has only a slight and not unpleasant smell. Owing to the large amount of air carried into the burner through the pipes the vitiation of the air is small, and, as there should be no objectionable impurities, the system is also clean and hygienic. In view of the small amount of petrol vapour used, the system is also claimed to be safe, and it is said that even a leak would not, in ordinary circumstances, give rise to any danger of fire or explosion. It is, however, essential that the consumer should purchase a trustworthy type of machine. In some of the earlier plants the composition of the mixture was apt to vary according to the load and

the temperature of the air, and there was even a tendency for petrol to condense in the pipes during cold weather. These defects should not exist in any trustworthy type of modern machine.

The chief elements in a petrol-air gas plant are the carburetter, in which the desired mixture of petrol and air is produced; the holder in which the gas is stored; and the compressor for the purpose of driving the gas through the pipes. The motive power may be supplied by a falling weight, hot-air engine, or water power. For country-house lighting, the falling weight is usually preferred on account of its simplicity. A trustworthy plant should operate quite automatically, yielding the same quality of gas, however many lights are turned on (within the limits of the plant), and should require little or no attention beyond filling up with petrol when necessary and occasionally winding up the weight.

A technical point of some interest is the percentage of petrol which it is desirable to include in the gas. In some cases, for example in the "County" petrol-air gas system, the comparatively rich mixture of 6 per cent. is preferred, and it is considered that this enables the plant to be designed and operated on highly scientific lines, and that it is of value in enabling a mixture of constant composition to be obtained, as well as desirable in the interests of safety.

In other well-known makes, for example, the Willett system, the percentage of petrol is 2 per cent. only. This is stated to operate quite satisfactorily, and it is also claimed that ordinary motor-car petrol can be used, and that no special variety of lighting spirit is required.

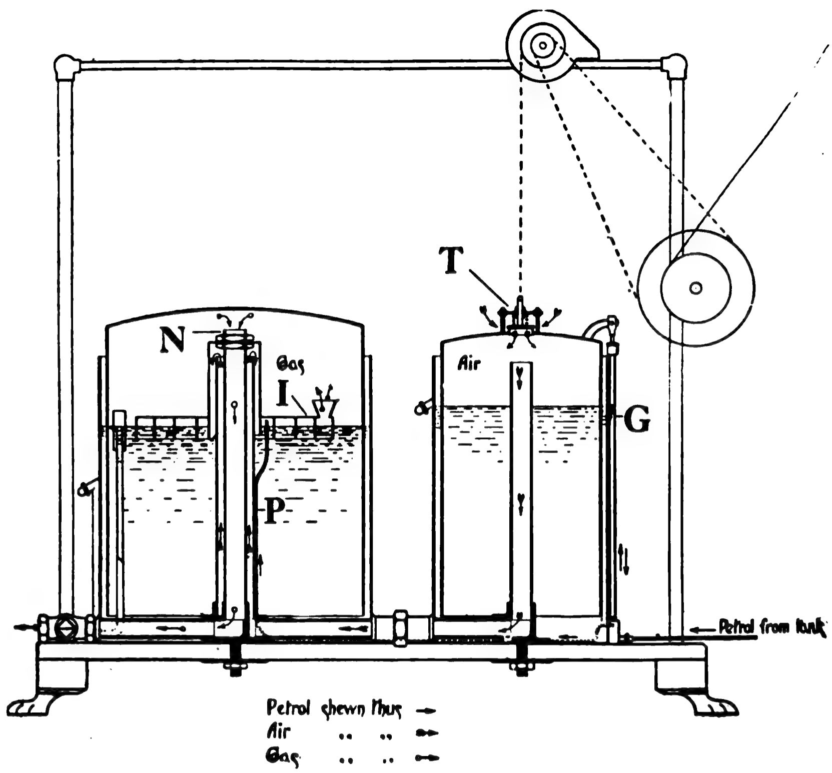

FIG. 3a.—Sectional view of "County" petrol-air gas plant. In this diagram three types of arrows are used to denote the respective paths taken by the air, petrol, and the resulting gas. The plant consists in the main of two copper bells working in water seals, the smaller of which acts as an air pump whilst the larger constitutes the holder for the gas as it is made. The air-pumping bell is made to rise and fall by means of the weights and on its upstroke takes in air through the valve T. On reaching the top of its stroke it is disengaged from the action of the weights (which are then held stationary), and the valve T closing, the air-bell falls by its own weight and drives air down the central pipe K into the larger bell *via* the pipe L and the annulus F. Before reaching the larger bell, however, it is caused to pass close along the surface of the carburetter by the baffle plate I. The petrol is delivered on to the surface of the carburetter by the petrol pump G in small amounts (a teaspoonful or so at a time) along the small pipe P. The petrol pump G, being attached directly to the air-bell, makes stroke for stroke with it, thus ensuring that air is never delivered without its complement of petrol under any conditions of running. The gas is delivered to the service down the central pipe at N.

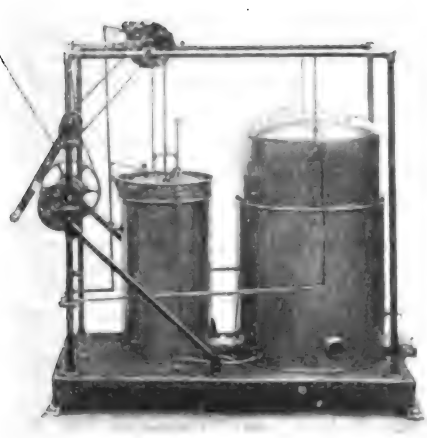

FIG. 3.—General view of "County" petrol-air gas plant.

A petrol-air gas system enables lights to be installed permanently in position and used either as central or units or wall brackets. The ordinary type of inverted burner used is of the Bijou type, from which as much as 70–80 candle-power may be obtained with new mantles. In favourable circumstances 100–120 of these lights can be run for a consumption of one gallon of petrol per hour. A small plant, feeding 10–20 lights, would probably cost about 25*l.*–35*l.* A larger size, capable of supplying 100 lights, about 100*l.*–120*l.* The complete cost of lighting installation, including plant, piping, and simple fixtures, would probably work out to between two and three times the above figures. Much, however, depends on the expenditure on fittings and the shed for housing the plant, and the distance from which materials have to be supplied. Prices have naturally been affected somewhat by the war. A consumer should remember that in remote places it is not always easy to get prompt technical assistance, and should therefore be careful to select a thoroughly up-to-date and trustworthy make of machine, even if somewhat more expensive than others on the market.

The above remarks have referred mainly to the use of petrol-air gas plants for country houses, but there are also opportunities for its use in small workshops, laboratories, etc. It has also been used occasionally for military camps and even for village lighting, b in such cases the nature of the area to be covered has an important bearing on the method of illumination supplied. In a large and scattered area the

question will arise whether it is worth while to run mains from the nearest gas or electrical supply; or whether it is not more economical, for a temporary installation, to rely exclusively on portable illuminants such as those described in the earlier portion of the article, and to avoid the use of piping altogether.

The fact that petrol-air gas can be readily applied for heating is also an advantage, especially in laboratories where bunsen burners and small heating appliances are much used. In country houses petrol-air gas may also be used for small cooking ranges, the usual size of which consumes an amount of petrol equivalent to about twenty lights. Stoves for use in the fireplace to heat rooms can also be supplied, but as a rule the small householder finds it preferable to use a coal or wood fire rather than incur the expense of installing the exceptionally large plant necessary to heat a number of rooms.

There remain to be mentioned the systems of light-

FIG. 4.—General view of Willett petrol-air gas plant. The plant consists of three chief parts—air compressor, petrol container, and spiral carburetter. The air compressor contains a cylindrical drum having in it a number of "scoops" so shaped as to produce a series of helical channels; the lower portion of the drum is filled with water. The petrol drum contains a number of small cups attached to the ends of rods which are fixed to a revolving spindle. These cups discharge their contents into a funnel-shaped receptacle, which in turn is controlled by the petrol regulator. Both the scoops in the air compressor and the spindle carrying the cups in the petrol drum are actuated by the suspended weight and work in perfect uniformity. The helical scoops in revolving take up a measured quantity of air which is compressed and discharged into a rectangular tank at the side, from whence it passes into the carburetter. Meantime the carburetter receives a regulated amount of petrol in the manner described. The inter-connection of the apparatus for supplying air and petrol maintains the correct proportions of these constituents; no holder is needed to store the gas which is generated as required, the machine automatically increasing its speed as more lights are turned on and *vice versâ*.

ing and heating which generate gas from heavy oils, fats, etc., which require heat for distillation. These systems are claimed to be highly economical on a large scale, and are usually employed for large buildings, institutions, factories, country railway stations, etc. Many railways make their own oil gas, which is compressed and used for carriage lighting.

The Mansfield oil gas producer is widely used for generating this quality of gas, and is claimed to be applicable to a wide variety of fuels, such as creosote, palm oil, kerosene, and even tallow and unrefined fat. The oil is stored in a suitable tank and guided in a fine stream into a retort heated by a wood or coal fire. In this way a permanent oil gas is produced which, after purification, is stored in a holder and supplied through pipes in the usual way. The gas produced may be used either with incandescent mantles or in a flat flame burner. It may also be used for heating, having a high calorific power. In some cases a portion of the gas is used for cooking and heating water, and the remainder is utilised to drive an engine and dynamo, furnishing electric light. A system of this kind naturally requires some attention, but is claimed to be capable of being worked by unskilled labour, and to be very simple in operation.

RESEARCHES ON SPRUE.[1]

SPRUE is a disease of chronic course, the main features of which are a frothy diarrhœa generally accompanied by a sore tongue; the disease as it progresses producing severe anæmia and exhaustion. The word sprue in English medical literature was first used by Manson in 1880, and is apparently the anglicised form of the Dutch spruw. One would like to know something of the origin of this Dutch word. The form sproo was also used in the year 1825 in Scotland for "a disease affecting the mouth of very young children." This disease is in all probability the same as thrush, and it is important to note in this connection that the condition of the tongue in thrush is similar to that in sprue. The word thrush, the origin of which is obscure, is not known before the seventeenth century, when Pepys speaks of "a fever, a thrush, and a hickup." It may also be mentioned that sprue in Scotland was the term used for "that which is thrown off in casting metals" (scoria).

The present work deals with the disease in Ceylon, where "Ceylon sore mouth" is one of the names for the disease. There are no figures available to show its frequency in Europeans or in the natives in the island, but that it does occur in the latter in various countries appears to be fairly certain. It is apparently also a disease determined by long residence in the tropics, though on all these points one speaks with hesitation as accurate data are not available. That dysentery is a common predisposing cause there appears to be no doubt, but whether there is any other closer connection between the two diseases is doubtful.

A sore tongue is one of the features of sprue, and microscopically the epithelium is found to be desquamating. This dead epithelium is infiltrated with yeasts, and in some cases the yeast threads appear to be actually invading the living cells. This is not, however, found to be the case in the stomach or gut, which are also inflamed, though the gut contents contain masses of yeast, and yeasts are the commonest organisms in motions passed shortly before death. This infection of the gut contents with yeasts does not, however, occur in other wasting diseases, the author very properly having made adequate control observations. Yeasts, then, not only can be cultivated from the majority of sprue stools and salivas, but in the acute stage they are the most prevalent organisms in the tongue lesions, saliva, and motions.

Now thrush, a common disease of infants in temperate climates, is generally believed to be due to yeasts, and in some respects—*e.g.* atrophy of the tongue epithelium—resembles sprue. The author, indeed, inclines to the view that yeasts are in fact the cause of the disease. One might object, however, that if this were so one would expect sprue to be a far commoner disease than it is, as yeasts in the tropics are ubiquitous. The view held by some authors that it has affinities to scurvy is an "attractive" one, and is supported by the beneficial effect of a fruit diet such as strawberries or bael fruit. This work is an interesting record of a careful research, valuable although inconclusive in its results. The plate of

[1] "A Report on Researches on Sprue in Ceylon, 1912–14." By Dr. P. H. Bahr. Pp. ix + 155. (Cambridge: At the University Press, 1915.) Price 7*s*. 6*d*. net.

sprue tongues has the merit of clearness, although the colours are not those of nature. We feel sure it would "pay" the Planters' Association in Ceylon to employ permanently one or more medical men to investigate the subject further. J. W. W. S.

SCIENTIFIC COMMITTEES ON NATIONAL PROBLEMS.

WE have referred from time to time to the various scientific committees appointed by the Government and scientific societies to deal with problems arising out of the war. It seems worth while to bring together now a list of such committees and a short statement of their work so far as that can be made known. It will be noticed that, with the exception of the Advisory Council of the Privy Council Committee and the Council and Committee of British Dyes (Ltd.), no provision is made for the payment of the experts in science and technology who are serving on other committees appointed by the Government and by scientific societies.

GOVERNMENT SCIENTIFIC COMMITTEES.

The Board of Invention and Research appointed last July to assist the Admiralty in co-ordinating and encouraging scientific effort in relation to the requirements of the Naval Service consists of the following Central Committee and Panel of Consultants, who advise the main committee on questions referred to them:—

Central Committee: Admiral of the Fleet Lord Fisher of Kilverstone (president), Sir J. J. Thomson, Sir Charles A. Parsons, and Dr. G. T. Beilby. *Panel*: Prof H. B. Baker, Prof. W. H. Bragg, Prof. H. C. H. Carpenter, Sir William Crookes, Mr. W. Duddell, Prof. P. F. Frankland, Prof. B. Hopkinson, Sir Oliver Lodge, Prof. W. J. Pope, Sir Ernest Rutherford, Mr. G. Gerald Stoney, and the Hon. R. J. Strutt. *Secretary and Naval Assistant*: Captain Thomas E. Crease, R.N.

We are informed by the Secretary of the Lords Commissioners of the Admiralty that the services of the members and the scientific experts on the Central Committee and the Panel of Consultants of the Board of Invention and Research are given gratuitously.

A Munitions Inventions Department of the Ministry of Munitions of War, with Mr. E. W. Moir as Comptroller, was appointed in August last to consider projects for inventions relating to munitions for warfare on land or matters pertaining thereto. The Advisory Panel of scientific and other experts is as follows:— Prof. A. W. Crossley, Mr. Horace Darwin, Dr. S. Z. de Ferranti, Mr. A. MacDougall Duckham, Mr. W. Duddell, Dr. R. T. Glazebrook, Col. H. E. F. Goold-Adams, Sir Robert A. Hadfield, Prof. J. S. Haldane, Col. N. B. Heffernan, Sir Alexander B. W. Kennedy, Mr. F. W. Lanchester, Prof. A. P. Laurie, Mr. Michael Longridge, Dr. W. H. Maw, Sir Hiram S. Maxim, Capt. A. U. Moore, Sir Henry Norman, Bart., Dr. F. G. Ogilvie, Maj.-Gen. Sir George K. Scott-Moncrieff, Mr. F. Wilfrid S. Stokes, Mr. J. Swinburne, Sir J. J. Thomson, Mr. A. J. Walter, Mr. C. J. Wilson, and Lieut.-Col. J. C. Matheson. The secretary to the Advisory Panel is Mr. H. W. Dickinson, Munitions Inventions Department, Princes Street, Westminster, S.W.

The Comptroller of the Munitions Inventions Department assures us that these gentlemen are not paid and that their services in all cases are voluntary. He informs us further that the work of the Department is co-ordinated with that of the Board of Invention and Research, and that a constant interchange of information and ideas takes place.

In July last, Mr. Arthur Henderson, President of the Board of Education, issued a White Paper describing the Government scheme designed to establish a permanent organisation for the promotion of industrial and scientific research. A sum of 30,000*l.* has been provided for the purposes of the scheme during the first year. The circular points out that the scheme is in no way intended to replace or interfere with the arrangements which have been or may be made by the War Office or Admiralty or Ministry of Munitions to obtain scientific advice and investigation in connection with the provision of munitions of war. The scheme provides for the establishment of:—(*a*) A Committee of the Privy Council responsible for the expenditure of any new moneys provided by Parliament for scientific and industrial research; (*b*) a small Advisory Council responsible to the Committee of Council and composed mainly of eminent scientific men and men actually engaged in industries dependent upon scientific research. The Committee of Council consists of the Lord President, the Chancellor of the Exchequer, the Secretary for Scotland, the President of the Board of Trade, the President of the Board of Education (who is to be vice-president of the Committee), the Chief Secretary for Ireland, together with such other Ministers and individual members of the Council as it may be thought desirable to add. The first non-official members of the Committee are:— Lord Haldane, Mr. A. H. D. Acland, and Mr. J. A. Pease. The first members of the Advisory Council are:—Lord Rayleigh, Dr. G. T. Beilby, Mr. W. Duddell, Prof. B. Hopkinson, Prof. J. A. M'Celland, and Mr. R. Threlfall, with Sir William S. M'Cormick as administrative chairman. The primary functions of the Advisory Council will be to advise the Committee of Council on (i) proposals for instituting specific researches; (ii) proposals for establishing or developing special institutions or departments of existing institutions for the scientific study of problems affecting particular industries and trades; (iii) the establishment and award of research studentships and fellowships. The Advisory Council will also be available, if requested, to advise the several Education Departments as to the steps which should be taken for increasing the supply of workers competent to undertake scientific research. It is contemplated that the Advisory Council will work largely through sub-committees reinforced by suitable experts in the particular branch of science or industry concerned. In pursuance of the Order in Council, *the Treasury has authorised the payment of remuneration to the members of the Advisory Council.*

The Minister of Munitions of War, with the concurrence of the Home Secretary, has appointed a committee to consider and advise on questions of industrial fatigue, hours of labour, and other matters affecting the personal health and physical efficiency of workers in munition factories and workshops. The committee is constituted as follows:—Sir George Newman (chairman); Sir Thomas Barlow, Bart., Mr. G. Bellhouse, Prof. A. E. Boycott, Mr. J. R. Clynes, Mr. E. L. Collis, Dr. W. M. Fletcher, Prof. Leonard E. Hill, Mr. Samuel Osborn, Miss R. E. Squire, and Mrs. H. J. Tennant.

The president of the Board of Agriculture and Fisheries has appointed a committee (consisting of Lord Middleton (chairman), Mr. Henry Chaplin, Sir Ailwyn Fellowes, the Hon. Alexander Parker, Major Sir M. Burrell, Bart., Sir G. Greenall, Bart., and Capt. M. S. Adye) to consider and advise the Board as to the steps which should be taken to secure the production and maintenance in England and Wales of a supply of horses suitable and sufficient for military purposes, especially on mobilisation.

The President of the Board of Agriculture and Fisheries has appointed a Departmental Committee to make arrangements with a view to the maintenance, so far as possible, of adequate supplies of fertilisers for the use of farmers in the United Kingdom. The Committee is constituted as follows:—Mr. F. D. Acland, Parliamentary Secretary to the Board of Agriculture and Fisheries (chairman); Mr. R. H. Rew, Board of Agriculture and Fisheries; Mr. T. H. Middleton, Board of Agriculture and Fisheries; Mr. G. J. Stanley, Board of Trade; Mr. J. Dundas White, Scottish office; Mr. H. Ross Skinner, Ministry of Munitions; Mr. E. J. Foley, Admiralty; and Mr. R. J. Thompson, Board of Agriculture and Fisheries.

The Secretary of State for the Colonies has appointed a committee to consider and report upon the present condition and the prospects of the West African trade in palm kernels and other edible and oil-producing nuts and seeds and to make recommendations for the promotion, in the United Kingdom, of the industries dependent thereon. The committee as at present constituted is composed of Mr. Steel Maitland (chairman), Sir G. Fiddes, Sir F. Lugard, Sir Hugh Clifford, Sir Owen Philipps, Mr. G. A. Moore, Mr. T. Walkden, Sir W. G. Watson, Bart., Mr. L. Couper, Prof. W. R. Dunstan, Mr. T. Middleton, Mr. T. Worthington, and Mr. T. Wiles.

British Dyes (Ltd.).

In February last the committee of users of dyes appointed to confer with the Board of Trade as to a national dye scheme adopted a scheme to form a company with an initial share capital of 2,000,000*l*., of which 1,000,000*l*. was issued in the first instance. The Government agreed to make to the company a loan for twenty-five years corresponding to the amount of share capital subscribed up to a total of 1,000,000*l*., and a smaller proportion beyond that total. The Government advance is to bear interest at 4 per cent. per annum, payable only out of net profits, the interest to be cumulative only after the first five years. In addition, and with the desire of promoting research, the Government undertook for a period of ten years to make a grant to the company for the purposes of experimental and laboratory work up to an amount not exceeding in the aggregate 100,000*l*. Chemical research was thus officially recognised and endowed as an essential factor in solving a national industrial problem.

Announcement was made in July that the board of directors of British Dyes (Limited) had established a Research Department, and had appointed Dr. G. T. Morgan, Royal College of Science for Ireland, Dublin, to become the head of the department. The board, which also appointed a Technical Committee, consists of Dr. M. O. Forster (chairman), Dr. J. C. Cain, Dr. G. T. Morgan, and Mr. J. Turner. An Advisory Council, which was appointed under the chairmanship of the late Prof. Raphael Meldola, is constituted as follows:—Prof. J. N. Collie, University College, London; Prof. A. W. Crossley, King's College, London; Prof. Percy F. Frankland, the University, Birmingham; Prof. G. G. Henderson, Royal Technical College, Glasgow; Prof. J. T. Hewitt, East London College, London; Prof. F. S. Kipping, University College, Nottingham; Prof. A. Lapworth, the University, Manchester; Prof. A. G. Perkin, the University, Leeds; Prof. W. H. Perkin, the University, Oxford; Prof. W. J. Pope, the University, Cambridge; Prof. J. F. Thorpe, Royal College of Science, South Kensington; and Prof. W. P. Wynne, the University, Sheffield. The members of the Technical Committee are *ex officio* members of the Advisory Council. *Payment is to be made to these chemists*, but the secretary of the company informs us that he is not at liberty to disclose the scale.

Royal Society.

On November 5, 1914, the council resolved "That the following be appointed a committee to organise assistance to the Government in conducting or suggesting scientific investigations in relation to the war, the committee to have power to add to their number, and to appoint sub-committees not necessarily restricted to fellows of the society:—Sir William Crookes, Prof. Schuster, Mr. W. Duddell, Sir Alfred Ewing, Dr. R. T. Glazebrook, Admiral Sir Henry Jackson, Sir Oliver Lodge, Sir William Ramsay, Lord Rayleigh, Sir Edward Thorpe." On January 21, 1915, an additional committee (the War Industries Committee) was appointed by the council to take over questions arising out of the war and affecting the industries of the country referred to the society by Government departments.

After a short experience the council came to the conclusion that it should be directly responsible itself for the co-ordination and control of the war work, and, accordingly, in June last the original committee was discharged, and council was constituted a General War Committee, the original sub-committees being re-nominated as four sectional committees. The functions of the War Industries Committee were transferred to the sectional Committee for Chemistry. These sectional committees have met regularly throughout the year, and have discussed and investigated many important questions, either submitted by Government departments or initiated by themselves. They have been placed in direct communication with the departments of Government concerned, and in each case representatives of the principal war departments have been appointed to serve on the committee.

In June last the council decided to form a register of those who are willing and able to aid in meeting the demands of the Government for scientific help. A circular letter inviting particulars of service proffered was sent to all the fellows, and met with a large response from them and from others to whom the project was made known. The register thus formed has been placed at the disposition of Government departments for reference.

A committee has been appointed to consider the advisability of entering into communication with technical and other scientific societies, with the view of establishing a permanent board for the discussion of questions in which joint action seems desirable. This committee will submit the draft of a scheme to the council, so as to put the council in a better position to arrive at a definite conclusion on the subject.

Those men of science who are working under the Royal Society's committees are not receiving any payment from the society for doing so.

Chemical Society.

With the object of assisting the Government to employ the chemical talent in the nation, the council of the Chemical Society in June last constituted itself a consultative body which should meet at frequent intervals to consider, organise, and utilise for the benefit of the country all suggestions, inventions, and offers of assistance it might receive.

On July 1 the president addressed a letter to every fellow of the society, inviting him to forward to the council any such suggestions and inventions, and asking him also to indicate on the form provided what services he could best render to the nation. A very gratifying response has been received to this appeal; many suggestions and inventions have been submitted to the council by fellows and by others, and numerous offers of voluntary assistance of whole or partial time, and even of relinquishing present positions altogether in order to devote their energy to the nation's service,

have been received from fellows in every part of the Empire. All these offers of assistance have been tabulated and a careful record has been kept.

In order to carry out effectively the consideration and reporting on the suggestions received, the council invited the co-operation of the following societies:—Royal Agricultural Society, Biochemical Society, Society of Chemical Industry, Society of Dyers and Colorists, Faraday Society, Institute of Chemistry, Institute of Metals, Institution of Mining and Metallurgy, Pharmaceutical Society, Physical Society, Society of Public Analysts. This was loyally and readily given by all; each society undertook to report on such inventions as came within its own special province by means of a special committee, of which it nominated six members in addition to two members of the council of the Chemical Society. In this way ten committees, each consisting of eight members, were formed, and cover the whole field of chemical activity. Each committee reports to the council the results of its deliberations, and those suggestions which are considered suitable are then sent on to the proper Government authorities, who have expressed their high appreciation of the valuable assistance thus afforded them. The society has also been instrumental in aiding the Ministry of Munitions with regard to the supply of chemists for the manufacture of munitions of war.

In addition to these special committees, which deal chiefly with matters of practical detail and utility, a general committee has been formed consisting of two members elected by the Chemical Society and by each of the above-mentioned societies. The object of this general committee is to consider and discuss all questions of general policy, not only those arising from the war, but also those matters on which it is desirable to have the opinion of a body thoroughly representative of every department of chemical science.

Further, the Chemical Society has been active in connection with the Government scheme for the organisation and development of scientific and industrial research under the auspices of the Board of Education. The president has addressed an urgent appeal to the fellows to exert their energy so as to make the scheme a success, and has invited them to forward to the society suggestions for suitable researches, especially those having a direct bearing on chemical industry and its promotion. Many valuable suggestions have already been received and are under consideration by the council. *No payment of any kind is being made to any member of these councils or committees for services rendered in connection with this work.*

PHYSICAL SOCIETY.

The council of the Physical Society decided in June last to make a register of the fellows, showing the special knowledge of each and the services each would be willing to perform voluntarily in connection with the war. In addition to this register, and quite distinct from it, arrangements were made for receiving from fellows any kind of scientific suggestion likely to be of use in the prosecution of the war. A number of suggestions have been received and have been passed to the proper Government departments.

As regards the register, a form was issued in July, and about half the fellows of the society returned it duly filled. Each recipient was asked details of:—(1) The branches of science, or appliances, of which he has special knowledge; (2) his laboratory or workshop facilities; (3) his willingness (*a*) to supply specialist information to the council, (*b*) to carry out experimental work, (*c*) to make models or drawings, (*d*) to give facilities to other workers, (*e*) to make calculations or numerical tables, (*f*) to make abstracts of technical papers, (*g*) to make reports on recent developments, to do clerical work, etc.

The various Government departments were notified in August of the existence of this register, and it was made use of by the Admiralty Inventions Board and by the Metropolitan Munitions Committee. Since then the society has supplied complete copies of the register, classified in subjects, to all the Government departments concerned and to certain other public bodies. *Any services rendered to the State under these schemes are given without remuneration by the fellows offering them.*

BRITISH ASSOCIATION.

As an outcome of the Manchester meeting, the British Association has invited the following gentlemen to serve on a committee to consider and report upon the question of fuel economy (utilisation of coal and smoke prevention), from a national point of view:—Prof. W. A. Bone, of the Imperial College of Science and Technology, London (chairman); Mr. E. D. Simon, chairman of the Manchester Air Pollution Committee (secretary); Profs. P. P. Bedson (Armstrong College, Newcastle-on-Tyne), J. W. Cobb and J. B. Cohen (Leeds University), H. B. Dixon (Manchester University), Thomas Gray (Royal Technical College, Glasgow), H. S. Hele-Shaw (London), L. T. O'Shea and W. P. Wynne (Sheffield University), and Richard Threlfall (Birmingham), together with Dr. G. T. Beilby (Glasgow), Mr. Ernest Bury, and Dr. J. E. Stead (Middlesbrough and the Cleveland district). The committee, which is empowered to add if necessary to its members, has been selected so as to include representative chemists, engineers, and technologists from all the principal industrial areas.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—By the will of the late Mr. Christopher Welch, of Wadham College, a well-known authority on musical subjects, a large sum has been placed at the disposal of the University for the endowment of scholarships in biology. This is the most important bequest of the kind that the University has received for many years. The conditions under which the scholarships may be gained and held, together with other matters of detail, will be announced in due course. The will contains the notable provision that under certain contingencies the money may go to the support of hospitals, but no hospital where vivisection is disallowed or discountenanced is to benefit, "anti-vivisectionists being enemies of the human race."

THE following courses of free advanced lectures for students of the University of London and others are announced:—Six lectures on "Stelar Anatomy in Angiosperms" will be given at Bedford College by Miss E. N. Thomas, on Mondays, beginning on January 24; nine lectures with practical work in dynamical meteorology will be held at the Meteorological Office, South Kensington, by Sir Napier Shaw, on Fridays, beginning on January 21. A practical course of statistical meteorology will be available for those who wish to work at that section. The fortnightly meetings at the Meteorological Office for discussion of important contributions to meteorology, chiefly in Colonial or foreign journals, will be resumed on Monday, January 10, at 5 p.m., and will be continued on alternate Mondays until March 20, inclusive.

THE Association of Public School Science Masters met on January 4 at the London Day Training College in Southampton Row, and a further meeting is being held as we go to press. The opening address by Sir William Osler was on "The Fateful Years: Fifteen to Seventeen." If he started from the years 1915 to

1917, what he said applied generally to the ages fifteen to seventeen. He pressed for the teaching at school of the combined course in chemistry, physics, and biology, generally known as the preliminary scientific for medical students. Discussion showed that this was already done in many of the schools represented, and that such work was recognised by almost every university except Oxford. In the afternoon Mr. Christopher Turnor was equally convincing in showing the school science course should afford a sound foundation for the duties of a rural landlord. Later Mr. M. D. Hill, of Eton, invited discussion on the management of school museums. A very useful adjunct to this conference is the exhibition of standard scientific text-books by publishing firms, and of scientific apparatus by several of the best-known dealers. Conspicuous among these were glassware and laboratory balances of British make.

THE fourth annual conference of educational associations is being held this week at the University of London. The arrangements have been made by a committee, on which nearly thirty associations are represented, and more than twenty of these hold their meetings under the same roof. Some meetings are sitting simultaneously, others follow in quick succession. The Educational Exhibition, representing sixteen different publishing firms, stands conveniently open for those who wish to see the newest school books. The inaugural meeting was held on Monday afternoon, January 3, when the Vice-Chancellor of London University, Sir Alfred Pearce Gould, took the chair, and Sir Oliver Lodge gave his address on "Education after the War." This proved to be a strong plea for science and natural history in the education of ordinary boys of thirteen and fourteen years of age. It is proposed to publish this and other papers in one volume after the conference. The conference is being extremely well attended; the audience at Sir Oliver Lodge's address filled the Great Hall of the University. After the address the Society of Education held an open meeting to hear Dr. A. R. Abelson on "The Comparative Study of Normal and Subnormal Children," and Mr. C. Burt on "Some Results of Mental and Scholastic Tests."

THE issue for December last of the Bulletin of the Massachusetts Institute of Technology is devoted to a catalogue of the officers and students of the institute, together with a statement of the requirements for admission and a description of the courses of instruction. So extensive are the activities described that the volume runs to nearly six hundred pages. Special interest attaches to the opportunities for research offered by the institute. Facilities for original investigation are afforded in all the departmental laboratories devoted to advanced work, as well as in separately organised research laboratories. Such laboratories have been provided for physical chemistry, applied chemistry, electrical engineering, and sanitary science, among other subjects. In addition, the institute maintains the Hawaiian Volcano Observatory, on the edge of the cliff that bounds the greater crater of Kilauea in Hawaii, where continuous registration and record of lava movements and effects peculiar to the district are carried out, and experiments on the kindred physical and chemical phenomena are undertaken. In accordance with an agreement between Harvard University and the institute, male students may receive certain benefits from the University. These benefits are confined to students registering in civil, mechanical, mining, electrical, or sanitary engineering. Such students will be entitled to the same rights and privileges as students in the professional schools of the University, and will be eligible for degrees from the University, in addition to those that they may receive from the institute.

THE report of the work of the Department of Technology of the City and Guilds of London Institute for the session 1914–15 has now been published by Mr. John Murray. The effect of the war on the country in general is reflected in the reduced numbers of students attending classes for technical training and presenting themselves for examination at the end of their courses of instruction. Apart from the large numbers who have enlisted in the Navy or Army, and whose technical training has been thereby suspended, both the extreme activity in certain industries and districts and the slackness and dislocation of business in other trades have been conditions unfavourable to the steady attendance and training of young men in technical classes. Although the total number of classes registered in technological subjects remained practically the same, the number of students in attendance fell from 55,996 to 47,050 this year—a reduction of nearly 16 per cent. on the previous year's figures. Correspondingly the number of candidates who presented themselves for examination in technology from centres in the United Kingdom fell from 23,119 to 15,623, a decrease of nearly 32½ per cent. Towards the close of the session several technical schools rendered valuable help to the Ministry of Munitions by using their workshops for making those articles connected with munitions of war for which their machinery was best adapted, and by training men to take their place in engineering firms executing Government contracts. Notwithstanding the war, the institute again held its examinations in India and the Overseas Dominions. New Zealand and South Africa each contributed contingents of candidates, and others were examined in Melbourne, Jamaica, Malta, and Singapore.

SOCIETIES AND ACADEMIES.

DUBLIN.

Royal Dublin Society, December 21.—Dr. J. M. Purser in the chair.—Prof. W. **Brown**: The change of length in nickel wires of different rigidities, due to alternating magnetic fields of frequencies up to 150 per second. The change in the length of nickel wire, due to the application of magnetic fields, depends on the rigidity of the wire, and on the frequency of the applied alternating magnetic field. For a magnetic field of 200 c.g.s. units with a decrease in the rigidity of about 12½ per cent., the contraction of the wire is increased about 60 per cent. for a direct magnetic field, and about 80 per cent. for an alternating magnetic field of frequency 150 per second; and when the frequency of the alternating magnetic field is increased six times the contraction is increased 24 per cent. for a light longitudinal load on the wire, and 9 per cent. for a load sixteen times greater, that is, when the wire has a rigidity of 810×10^6 grams per sq. cm.—G. H. **Pethybridge**: The verticillium disease of the potato. The disease is a specific type of hadromycosis caused by the fungus *V. albo-atrum*, R. et B., which invades the wood vessels of all the organs of the plant and causes its premature death by desiccation. The fungus enters the wood system of the new tubers, hibernates there, and causes the infection of the plants produced when such tubers are used as "seed." The fungus has been obtained and studied in pure culture, and infection experiments have proved its parasitic nature.—Prof. H. H. **Dixon** and W. R. G. **Atkins**: Osmotic pressures in plants. VI.—On the composition of the sap in the conducting tracts of trees at different levels and at different seasons of the year. Sap centrifuged from the wood at the top of the stem

of a deciduous tree has a greater pressure than that from the root and lower portions. The excess is greatest in early spring, when the sugar content becomes very considerable, though appreciable quantities of sugars, mainly sucrose, are always present. The electrolytes increase noticeably in late spring. In evergreens a more uniform distribution of osmotic pressures is found in the stem, and the seasonal changes are not so sharp.

EDINBURGH.

Royal Society, December 6, 1915.—Dr. John Horne, president, in the chair.—C. **Tweedie**: The *Geometria organica* of Colin MacLaurin. This was a presentation in modern form of MacLaurin's treatise on the properties of plane curves, a treatise which was much admired by Newton. With the exception of the French school of geometers, mathematicians had largely neglected this work of MacLaurin, who had enunciated theorems and established relations which are usually ascribed to later workers. In presenting the treatise in English dress Mr. Tweedie had greatly simplified the analytical methods, but had left practically untouched the geometrical reasoning, which for elegance and lucidity could not be surpassed.—Prof. R. J. **Harvey-Gibson** and Miss M. **Bradley**: The anatomy of the stem of the Papaveraceæ. This was the first of a series of careful investigations into the characters of plants belonging to the lower Dicotyledons. Throughout the Papaveraceæ the stem structure was very uniform, the chief characteristics being (*a*) a sub-epidermal band of chlorophyll-bearing tissue, (*b*) a sclerotic pericycle (with some exceptions), (*c*) a massive pith, often fistular.—W. E. **Collinge**: A small collection of terrestrial Isopoda from Spain, with descriptions of four new species. The collection was from the Cambridge University of Zoology, and the author was indebted to the kindness of Dr. Leonard Doncaster for the opportunity of examining it. There were seven species, of which four were certainly new, but two were too imperfect to admit of identification. The new species were *Porcellio batesoni*, *P. explanatus*, *Armadillidium nitidulus*, and *Cubaris invenustus*.

December 20, 1915.—Dr. John Horne, president, in the chair.—E. G. **Ritchie**: The torsional vibrations of beams of commercial section. In beams of circular section the torsional rigidity depends on the polar moment of inertia of the area. For non-circular sections de St. Venant had proved that important corrections must be applied. In a previous paper Mr. Ritchie showed that the effective moment of inertia to be used instead of the polar moment of inertia in beams of commercial section, such as the I-section, the Channel, the Tee, the Angle, could be expressed in the form A^n/m, where A is the area of section and n and m are constants depending upon the type of section. In the present paper, experiments on the torsional vibrations of loaded beams of commercial section were carried out and the results compared with the theoretical values indicated. The comparisons were satisfactory.—E. H. Cunningham **Craig**: The origin of oil shale. After a detailed discussion of the field evidence regarding the occurrence of oil shales and oil fields in different parts of the world, the author elaborated a new theory of the origin of oil shale, the main points of which were as follows:—Kerogen is formed by the inspissation of petroleum, during which the nitrogen and sulphur compounds become concentrated in the most inspissated or weathered products. At a certain stage of inspissation, which is reached gradually, the organic matter becomes insoluble in carbon disulphide and ceases to be bitumen. An oil shale is formed by the power of certain clays or shales of absorbing and adsorbing inspissated petroleum, particularly unsaturated hydrocarbons.—Dr. Thomas **Muir**: The theory of circulants from 1880 to 1900.

PARIS.

Academy of Sciences, December 20, 1915.—M. Ed. Perrier in the chair.—G. **Bigourdan**: Jean de Lignières, his nationality and work.—Edouard **Branly**: The conductivity of a thin layer of air between two metallic surfaces. Details of experiments on the conductivity of thin layers of air, of known thickness, for continuous currents.—G. **Gouy**: The form of the X-rays. A theoretical examination of the problem of the production of real foci of the X-rays, by the aid of crystalline reflection.—M. de **Sparre**: The trajectory of projectiles thrown with a great initial velocity with an angle of projection in the neighbourhood of 45°, and under the influence of the diminution of the density of the air.—J. **Guillaume**: Observations of the Taylor comet, made with the Brünner equatorial of the Lyons Observatory. Two positions are given for December 11, one for December 13. On December 6, the comet showed as a nebulosity of about 1′, with slight central condensation. Magnitude, 9·5; colour bluish. On December 11 it appeared brighter; magnitude not under 6.—Paul **Bruck**: Observation and first elements of the Taylor comet.—Nicolas **Kryloff**: The convergence of quadratures.—Marcel **Brillouin**: The problems of mathematical physics and their general numerical solution. A method of constructing series which lead to the numerical calculation of solutions of all problems of mathematical physics defined by one or more linear partial differential equations, whatever the form of the limiting surface.—A. **Targonski**: The value of the charge of the electron deduced from the calculation of Brownian deviations. A comparison of Millikan's method, based on the Stokes-Cunningham formula, and that based on the observation of Brownian motion. Leaving out of account experiments where the particles have been produced in the electric arc, the results obtained by the two methods agree better when the mean free path of the molecules of the gas is large relatively to the radius of the particle observed.—Gabriel **Sizes**: Complement of the law of resonance of sonorous bodies.—Jean **Danysz** and Louis **Wertenstein**: An attempt to influence the velocity of radio-active transformations by the α rays. From the results of the experiments described it is concluded that even encounters with α particles with atoms are powerless to provoke an artificial radio-activity, or a premature transformation of the atom struck.—Albert **Colson**: Contradictions between the found and calculated solubility of certain sodium salts.—B. **Bogitch**: The solidification curve of the system ammonium nitrate—lead nitrate.—L. **Tschugaeff** and J. **Tschernjaeff**: The series of triamino-aquo salts of bivalent platinum $(Pt.3NH_3,H_2O)X_2$.—M. **Deprat**: The discovery of the Middle and Upper Cambrian in Tonkin, in Kwong-Si, and in southern Yunnan.—C. **Sauvageau**: The heterogamic sexuality of *Saccorhiza bulbosa*.

NEW SOUTH WALES.

Linnean Society, October 27.—Mr. A. G. Hamilton, president, in the chair.—R. **Etheridge,** Jun., and J. **Mitchell**: The Siluran trilobites of New South Wales, with references to those of other parts of Australia. Part v., Encrinuridæ. The genera of the family are briefly referred to in a general way, and the foreign history of the genus Encrinurus is reviewed.—E. W. **Ferguson**: Revision of the Amycterides. Part iv., Sclerorinus (Section i.) [Coleoptera: Amycteridæ]. The total number of species recognised is sixty-one. Section i. comprises one group of nineteen species, of which two are described as new. This group is strongly represented in South Australia, extending, on the east, into the coastal and mountain districts of Victoria and Tasmania.—R. **Greig-Smith**: Contribu-

tions to a knowledge of soil fertility. No. xiii., The toxicity of soils. The formation of toxins, in a soil free from vegetation, occurs most rapidly when the temperature is near 28°, and the moisture-content is one-fourth of the water-holding capacity. The soil-extract is, as a rule, either nutritive or toxic, according to the volume of water, relative to the soil, used in preparing the extract. It is most nutritive when the ratio of soil to water is 1 : 0·5, and most toxic when it is 1 : 1. A previous drying or chloroforming of the soil causes the extract to be much more nutritive than when the raw soil is used. The addition of small quantities of dextrose to soil brings about a more rapid production of toxin, while aeration of the treated soil accelerates the formation and decay of the toxin.—W. W. **Froggatt**: Notes on a collection of Australian and other Myriapods. Notes on nine species are offered; one of them from the New Hebrides, a second from Queensland and the New Hebrides; the others, including *Scolopendra morsitans*, Linn., from various Australian localities, chiefly in the western portion of New South Wales. *S. morsitans*, originally described from India, and with a wide distribution, is the common centipede of the interior of Australia.—H. W. **Brölemann**: Description of a new Myriapod from New South Wales. A species of Schizoribautia from Brewarrina and Nevertire, N.S.W., is described as new.

BOOKS RECEIVED.

The Scientists' Reference Book and Diary, 1916. (Manchester: J. Woolley, Sons, and Co., Ltd.) 2*s.*

Dinosaurs, with Special Reference to the American Museum Collections. By W. D. Matthew. Pp. 162. (New York: American Museum of Natural History.)

The Marine Biological Station at Port Erin (Isle of Man), being the 29th Annual Report of the Liverpool Marine Biology Committee. Drawn up by Dr. W. A. Herdman. Pp. 57. (Liverpool: C. Tinling and Co., Ltd.)

Transactions of the Royal Society of Edinburgh. Vol. li., part ii. (No. 7). Studies on the Development of the Horse. (1) The Development during the Third Week. By Prof. J. Cossar Ewart. Pp. 287–329+plates ix–xviii. (Edinburgh: R. Grant and Son.) 7*s.*

Hazell's Annual for the Year 1916. Edited by Dr. T. A. Ingram. Pp. 528. (London: Hazell, Watson and Viney, Ltd.) 3*s.* 6*d.* net.

Proceedings of the Yorkshire Geological Society. Vol. xviii. Bibliography of Yorkshire Geology (C. Fox-Strangway's Memorial Volume.) By T. Sheppard. Pp. xxxvi+629. (London and Hull: A. Brown and Sons, Ltd.)

Penrose's Annual. Vol. xxi. The Process Year Book. Edited by W. Gamble. Pp. 112+plates. (Bradford and London: Lund, Humphries and Co., Ltd.) 5*s.* net.

Algebraic Equations. By Dr. G. B. Mathews. Second edition. Pp. 64. (Cambridge: At the University Press.) 2*s.* 6*d.* net.

A First Course of Geometry. By Dr. C. Davison. Pp. 89. (Cambridge: At the University Press.) 1*s.* 6*d.*

Exercises in Practical Physics. By Profs. A. Schuster and C. H. Lees. Fourth edition. Revised. Pp. x+379. (Cambridge: At the University Press.) 7*s.* net.

Archæological Excavation. By J. P. Droop. Pp. x+80. (Cambridge: At the University Press.) 4*s.* net.

Collected Papers on Spectroscopy, with a Supplementary Paper not Heretofore Published, and a Classified Index. By Prof. J. D. Liveing and Sir J. Dewar. Pp. xv+566. (Cambridge: At the University Press.) 30*s.* net.

Euclid's Book on Divisions of Figures, with a Restoration based on Woepcke's Text and on the Practical Geometriæ of Leonardo Pisano. By Prof. R. C. Archibald. Pp. 88. (Cambridge: At the University Press.) 6*s.* net.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 6.

OPTICAL SOCIETY, at 8.—The Use of a Graticule in Binoculars and Telescopes: S. D. Chalmers.

FRIDAY, JANUARY 7.

GEOLOGISTS' ASSOCIATION, at 7.30.—The Discovery and Excavation of a Large Specimen of *Elephas antiquus* near Chatham: Dr. C. W. Andrews.

MONDAY, JANUARY 10.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—The Adriatic Slavs and their Relation to the Future Overland Route to Constantinople: Sir A. Evans.

TUESDAY, JANUARY 11.

INSTITUTION OF CIVIL ENGINEERS, at 5.30.—The Electric Locomotive: F. W. Carter.

THURSDAY, JANUARY 13.

ROYAL SOCIETY OF ARTS, at 4.30.—The Romance of Indian Surveys: Sir T. H. Holdich.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Predetermination of the Performance of Dynamo-electric Machinery: Prof. Miles Walker.

MATHEMATICAL SOCIETY, at 5.30.—The Transition from Vapour to Liquid, when the Range of the Molecular Attractions is Sensible: Sir J. Larmor.—(1) A Note on the Uniform Convergence of the Fourier Series $\Sigma a_n \sin n\theta$; (2) A Condition for the Validity of Taylor's Expansion: T. W. Chaundy.

FRIDAY, JANUARY 14.

ROYAL ASTRONOMICAL SOCIETY, at 5.

MALACOLOGICAL SOCIETY, at 7.—The Operculum of the Genus Bursa (Ranella): Rev. A. H. Cooke.—The Shells of the South African Species of Lepidæ: E. A. Smith.—(1) A Volume of Plates Prepared by Rackett for the Second Edition of Pulteney's "Dorsetshire Shells" in Hutchin's "History of Dorset"; (2) Lovell Reeve's "Elements of Conchology," with some Dates of Publication: A. Reynell.

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THURSDAY, JANUARY 13, 1916.

AMERICAN STEEL STRUCTURES.

Structural Design. Vol. ii. *Design of Simple Structures.* By Prof. H. R. Thayer. Pp. ix + 495. (London: Constable and Co., Ltd., 1914.) Price 16*s.* net.

THIS is a second volume of a treatise, of which another volume is to follow. It can be heartily commended as a competent attempt to grapple with, and reduce to order, a wide and difficult subject. No English book known to us deals in similar detail with the considerations which should be present in the mind of a designer, or gives equal help in dealing with practical problems. A large number of examples of design are worked out in numerical detail, and this gives the author an opportunity of introducing the discussion of various matters which cannot be reduced to exact rule, but are such as would be pointed out by a chief draughtsman to his subordinate or by a professor to his student at the drawing-board. Thus tips can be given by which difficulties can be obviated or evaded, and modifications indicated where rational formulæ lead to unpractical dimensions. Not only rules of applied mechanics are attended to, but considerations of weight, cost, durability, and convenience of erection are equally stated.

The technical terms may present difficulty to some English readers, and a bilingual glossary would be useful. Ties (sleepers), cords, bents, girts, dapped ties, splice (for joint), and kips (as units of load) are foreign in this country. Probably unavoidably a very large number of empirical formulæ are introduced, and the basis for these or the reason for the selection of the constants suggested is not generally clear. They must be taken on the authority of the author. It is not obvious why the weights of single, double, or treble I beams for the same load should be as 21, 30, and 36, and a built beam as 32 (p. 7), and so in other cases. There are other cases where abbreviation has been carried to a point which will give trouble to readers, but this but little detracts from the considerable merit of the book.

Naturally the chief subjects treated are bridges, plate and braced, for roads and railways, and viaducts for elevated railways. But steel-framed mill and office buildings are treated fairly fully, and railroad stations, mine structures, stand pipes, and steel tanks more briefly. A feature of the work is the tabulation of references to technical journals and memoirs.

An interesting chapter is that on high steel-framed buildings. The author points out that the executive offices of great corporations must be in large cities, and central to facilitate intercourse. Hence arise sections of a city where land is very valuable and high buildings are necessary to secure a fair return on the property. In America there has been a steady drift towards higher buildings, the highest being the Woolworth building with fifty-five stories or 775 ft. high On the other hand, the disadvantages of the system seem serious enough—exclusion of sunlight from streets, difficulty of fire protection, overcrowding of the water and sewer systems. In the prevalent "cage construction" all loads, including the weight of the walls, are carried at each floor-level by the steel. From the large and increasing sum bringing no return during erection, the work has to be done with remarkable speed.

The author states that it is possible to replace an old building by a new one twenty-five stories high in a year. Work at different heights is prosecuted simultaneously, and as concerns the steelwork, two to four stories may be erected per week. Many of the details of floors and fire protection of steelwork, etc., for high buildings will be new to English readers. The provisions required in the United States for water, drinking water, hot water, elevators, heating (by waste-steam radiators), lighting, telephone, and telegraph are more elaborate than anything exacted in this country.

CANADA.

Stanford's Compendium of Geography and Travel. (New Issue.) *North America.* Vol. i. *Canada and Newfoundland.* Edited by Dr. Henry M. Ami. Second edition, revised. Pp. xxviii + 1069. (London: E. Stanford, Ltd., 1915.) Price 15*s.* net.

IT is inspiriting, in these times of national self-questioning, to turn to a book like this, in which a true Canadian tells with glowing pride of the magnificent and continuous growth of the great Dominion as an integral part of our Empire. The book has been written to replace an earlier edition by Dr. S. E. Dawson, published in 1897; and it shows that the interval has been characterised by a national vitality and progress even more vigorous than those of any previous period. Exploration pushed forward everywhere; old boundaries changed; new territories settled; population enormously increased; fresh industries established; railway and shipping enterprises of world-importance planned and carried through; old political difficulties swept away and others, formerly unthought of, now to the fore; and, through all, as a dominant note, an ever-increasing

X

sense of Canadian unity and of Imperial responsibility!

In varying degree it is the story also of Australia, of New Zealand, of South Africa; and is the best vindication of our method or lack of method in the world of affairs. As this book will show, our mistakes in the past have been many, but they have been repairable piecemeal. When an unnaturally rigid organisation breaks down, it breaks down utterly.

Dr. Ami has proved himself well qualified for the task of preparing this bird's-eye view of the Dominion. His long service on the Geological Survey of Canada has not only endowed him with stores of direct knowledge, but has also brought him in contact with the best and most recent authorities for other information, as his preface indicates.

His account of the history and characteristics of the maritime provinces and Old Canada, especially of the Province of Quebec, are of peculiar interest to the British reader in presenting a full and sympathetic view of the position of the French-speaking Canadians, whose loyalty to the Empire in the present crisis is doubly assured, and whose influence upon the future of Canada is bound to be of prime consequence.

In the first three chapters Dr. Ami deals with the Dominion as a whole, its exploration, its surrounding seas, its great lakes and their geological evolution, its spacious geography, its flora and fauna, its aboriginals (no longer to be regarded as a moribund people), and its general system of government. Then follow the chapters (iv.–xx.) in which the separate provinces and territories, along with the independency of Newfoundland, are severally dealt with, in each case with an entertaining outline of its individual history and an accurate account of its physical features, geological structure, present economic development, and future possibilities; while all along runs the cheery streak of good Canadian satisfaction and optimism, illuminating everything, even the tables of statistics. The summary of our knowledge of the cold wilderness and archipelago north of the Arctic Circle, contained in chapter xix., and the concluding bibliography, are noteworthy additions to the value of the book as a work of reference.

The critical reader may notice now and again a repetition of the same facts and statements in almost identical terms under different headings; but this is perhaps excusable where so many of the sections are more or less independent and may have to be consulted separately. The book is illustrated with many clear maps, and with well-chosen views of scenery, etc., as text-figures. Most of the latter are reproduced from photographs, and are sometimes good, sometimes smudgy. These unimpressive process-photographs are becoming superabundant, however, and one regrets the passing of the old line-engravings and wood-cuts, which, though less accurate, more directly carried their intention to the eye.

G. W. L.

PRACTICAL BIO-CHEMISTRY.

Practical Organic and Bio-chemistry. By R. H. A. Plimmer. Pp. xii+635. (London: Longmans, Green and Co., 1915.) Price 12s. 6d. net.

THIS work is a development of the author's "Practical Physiological Chemistry," which had been used by him for teaching purposes for some years. New sections on organic chemistry and the organic substances found in plants have been added, and the work thus rendered much wider in scope, whilst the inclusion of many of the less familiar experimental methods has made it of greater value to the advanced student or investigator. As now presented the book appeals to a very wide audience. The student of medicine, for whom, even in its expanded form, it is still primarily intended, will find in it instruction on every point of practical organic or physiological chemistry which is likely to be of use to him, and may, if he think fit, advance much further in these subjects than is at all usual. At the same time, workers in every branch of biochemistry will find a considerable amount of information, not only concerning the fundamental substances which form the chemical basis of all living organisms, but also, with few exceptions, dealing with that section of the subject in which they are specially interested.

An unusual feature for a work on practical chemistry is the inclusion of a considerable amount of descriptive matter, unaccompanied by any practical details, and often dealing with very complex subjects, such as animal and vegetable colouring matters, the terpenes, etc. Although the information thus supplied is of great interest, and is well and clearly presented, it is in many cases necessarily extremely condensed, and seems somewhat out of place in a professedly practical work. The omission of much of this purely descriptive or theoretical matter might possibly have rendered possible the production of the book at a price less formidable to the student.

Another feature of the work which is also a little unusual is the inclusion of what may be termed "ordinary" organic chemistry, along with more purely biochemical and physiological subjects. There are probably few text-books in which Friedel and Crafts' reaction, the preparation of

a peroxydase solution, and the analysis of diabetic urine receive impartial attention. There is, however, an advantage in this plan, for the worker proceeds from the simpler "organic" preparations, in the course of which he acquires the necessary technique, to the more difficult biochemical methods. Owing, no doubt, to the necessity for compression, some of the directions given for preparations appear to be scarcely explicit enough for a beginner, unless supplemented by verbal instruction—perhaps not a very serious fault.

Turning to the more purely biochemical part of the work, we find that a large number of preparations are described, and a very complete series of illustrative experiments given in connection with the more important branches of biochemical work. Too little stress is, perhaps, laid on the importance of the various factors by which biochemical processes are affected. Thus, the determination of acidity—whether by electrical methods or by the use of indicators—is not described, and, in the section on fermentation, the reference to the sensitiveness of enzymes to salts, acids, and alkalis scarcely does justice to the importance of the subject.

Throughout the book the analytical relations of the substances mentioned and the processes of analysis employed in biochemical work are extremely well and fully described, the author's great experience in this branch of the work enabling him to speak with special authority. Particularly is this the case with the analysis of urine—both normal and pathological—the micro-methods of Folin being included, the analysis of tissues, the examination of the gases of the blood, and the measurement of the activity of enzymes.

As will be seen from the foregoing, the author has brought together an extremely valuable collection of information concerning substances, processes and methods of biochemical interest, and all students and workers owe him a debt of gratitude for the industry and patience which he has displayed in the accomplishment of this task.

A. HARDEN.

TINEID MOTHS OF CENTRAL AMERICA.

Biologia Centrali-Americana. Insecta. Lepidoptera-Heterocera. Vol. iv. By the Rt. Hon. Lord Walsingham. Pp. xii+482, plates x. (London: Dulau and Co., Ltd., 1909–1915.)

AS already stated in NATURE (December 23, 1915, p. 448), the publication in 1915 of the volume under review and of Dr. Godman's "Introductory Volume" marks the completion of the great series of works forming the Biologia Centrali-Americana. Lord Walsingham's contribution deals with the micro-moths of the groups Tineina, Pterophorina, and Orneodina, and includes a supplement to Pyralidina and Hepialina. As he explains in his introduction, the task has been accomplished, not by himself alone, but by the combined efforts of three specialists, the other two being Mr. J. Hartley Durrant, and Mr. August Busck of the United States Department of Agriculture. Lord Walsingham had already commenced to study the material so long ago as 1895, but several causes have delayed the appearance of the volume, notably the decision to extend it far beyond its original scope as a faunistic treatise, "and to give it special value for the future guidance of all students of the Microlepidoptera." It soon became apparent that previously adopted lines of classification were inadequate for dealing with so little known a fauna. Therefore a correlation of the various systems and a revision of the limits of existing family-divisions were undertaken—a study which has produced interesting results.

Earlier writers relied to a large extent on secondary sexual characters, not only for specific, but also for generic, distinctions. These have been discarded, for generic purposes at least, in favour of characters found in both sexes, this being probably the first time that such a principle has been applied to the classification of Tineina as a whole. The reason for this change, which has involved the suppression of very many genera, is that when the structural modifications hitherto used "are carefully examined in relation to the vast number of forms in a great continental fauna, they are found to blend one into another by such infinitesimal gradations as to impede rather than to assist a conscientious worker." For example, the genus Felderia was founded on the strongly bipectinate antennæ of the male, a character found to be modified by such countless and minute gradations as to be quite untrustworthy for purposes of generic differentiation. Again, the family Acrolophidæ, after being exhaustively examined, must be regarded as consisting practically of one large genus, in which, however, the species are separable by secondary sexual differences. Varying degrees of structural divergence are often concomitant with most confusing similarity of general appearance, so much so that, in the case of the genitalia, the differences may almost convey the impression of having been purposely evolved to prevent interbreeding of forms among which confusion might otherwise occur.

On the last page of the introduction is a census of the forms enumerated: 27 families, two described as new; 225 genera, 54 described as new;

1025 species, 586 described as new. These forms are illustrated by ten plates containing 350 coloured figures and by a number of structural text-figures. Notwithstanding this there are grounds for thinking that only the fringe of the Central American microlepidopterous fauna has been touched. Dr. Godman's collectors had to obtain insects of all orders, and could not devote attention to micro-moths to the exclusion of other groups. Thus the most able collectors could scarcely obtain samples of more than a portion of the Microlepidoptera. These insects cannot be packed and preserved so easily as those of many other groups. They require special treatment of a very delicate kind, which it is not easy to give when collecting all orders, as the writer of this review can testify from his own experience in the forests of certain tropical islands.

The extended aim of the work has necessitated a vast amount of bibliographical research. In connection with questions of nomenclature a protest is entered against the practice, now becoming prevalent, of arbitrarily "selecting and maintaining generic names by summary fixation of types without due regard for previous work done by critical authors." Lord Walsingham contends that however necessary in the interests of priority and uniformity arbitrary rules may be for the present and future, they should not be made retrospective. When the limits of genera have been modified by the careful and expert work of earlier writers, such modification must be taken into account; otherwise a death-blow may be struck at the whole system of true priority.

The names of the three specialists responsible for it are a guarantee of the high quality of this treatise, and its appearance as the last systematic volume of the Biologia forms a fitting close to the monumental work of Dr. Godman and the late Mr. Salvin. HUGH SCOTT.

BOTANY, NATURE STUDY, AND GARDENING.

(1) *The Study of Plants: an Introduction to Botany and Plant Ecology.* By Dr. T. W. Woodhead. Pp. 440. (Oxford: At the Clarendon Press, 1915.) Price 5s. 6d.

(2) *A School Flora for the Use of Elementary Botanical Classes.* By Dr. W. M. Watts. New edition. Pp. viii+208. (London: Longmans, Green and Co., 1915.) Price 3s. 6d.

(3) *The Surrey Hills.* By F. E. Green. Pp. x+252. (London: Chatto and Windus, 1915.) Price 7s. 6d. net.

(4) *In Pastures Green.* By P. McArthur. Pp. xi+364. (London and Toronto: J. M. Dent and Sons, Ltd., 1915.) Price 5s. net.

(5) *How to Lay Out Suburban Home Grounds.* By H. J. Kellaway. Second edition. Pp. x+134. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1915.) Price 8s. 6d. net.

(1) THE course of work in elementary botany set forth in this book is such as to fulfil admirably the author's main object: the establishment of the fundamental principles of plant physiology; while the prominence given to plant ecology and the admirable manner in which this aspect of the subject is treated are just what one would expect from a writer who has contributed so materially to the progress of this branch of botany. Form and structure, however, are by no means neglected in Dr. Woodhead's well-planned course, but merely made subservient to physiology and ecology; morphological facts are treated in relation to function and habitat, while the necessary morphological data are introduced where required in the discussion of the various types of vegetation. The book is liberally illustrated, and the figures are mostly new and all extremely good, a large proportion being photographs. It would be very difficult to find a better introduction to the study of plant ecology than is given in the section, extending to about ninety pages, with fifty illustrations of which many are very fine photographs of vegetation, devoted to this subject. We could wish that climatic factors had been somewhat more fully dealt with, and it seems rather inadvisable at present to introduce any terms for vegetation units beyond the non-committal "plant community" in a book intended for young students. It is safe to predict that Dr. Woodhead's book will be widely adopted for class use, and it is to be hoped that it will come into the hands of every teacher of botany.

(2) Watts's "School Flora" is too well known and extensively used by teachers and students of elementary botany to require further commendation for its good points—its cheapness and handiness, and the usefulness of the keys to the families, genera, and species of vascular plants. This new edition is stated in the preface to have been "thoroughly revised," but the chief features of the revision appear to consist in the addition of a key for the identification of trees and shrubs from their leaves, and in the extension of the list of schools near which the rarer plants grow—this fact being noted in connection with the description of each plant concerned. The first feature mentioned is useful, but the second strikes us as worse than useless; it appears somewhat foolish

and dangerous to indicate in a book of this sort the habitats of plants in the increasing rarity and threatened extermination of which teachers and students of elementary botany have undoubtedly assisted. At this date, too, it is ridiculous to retain the old plan of inserting the Coniferæ in the Dicotyledons, calling the vascular cryptogams "Acotyledons," and so forth.

(3) This pleasant book on the Surrey hills is rather of literary than scientific interest, but nevertheless it ought to be in the hands of all who visit this attractive region with the primary object of studying its flora and fauna. Such readers will find much of the book of real service as a guide to the topography, even though it is only casually interpolated in the author's entertaining chat concerning past and present dwellers in what is, unfortunately, rapidly becoming suburb rather than countryside.

(4) This book also, though dealing with quite another aspect of country life, is scarcely of scientific interest; in fact, as the author tells us, the reader who consults these pages for scientific information does so at his peril, though he will certainly find much of interest concerning various aspects of farming. The book is cast in the form of a diary, dealing with all kinds of farm work at different seasons of the year. Though written in a racy and humorous style, the book contains a vast amount of information which will prove of interest and value to a wide circle of readers, but more particularly so to those who, like the author himself, are looking forward to the inevitable land-hunger which will be one of the results of the present war, and will surely force a solution of the land problem. "Back to the land" is the author's text, and his experiences, as here related, will undoubtedly be helpful to others who are thinking of going back to the land.

(5) The purpose of this book is indicated in the title; and so practical and thorough is the author's treatment of his subject that it cannot fail to be of value to all who are interested in the planning of suburban gardens and home surroundings in general. Even those who cannot begin at the beginning, but must make the best of what the builder has done, will find here many useful hints regarding the laying out and planting of lawns and gardens, the kinds of trees, shrubs, and herbaceous plants to choose, etc. Some striking photographs are given to illustrate the manner in which well-built and pleasantly situated houses of moderate size may be rendered more attractive, and even ugly and ill-placed houses beautified, by following out the schemes set forth in detail by the author. F. C.

OUR BOOKSHELF.

Elementary Practical Metallurgy for Technical Students and Others. By J. H. Stansbie. Pp. viii+151 (London: J. and A. Churchill, 1915.) Price 3s. 6d. net.

LABORATORY courses for metallurgical students have often in practice consisted merely of instruction in assaying. The needs of evening students attending technical classes are not, however, met by such courses, and a complete change from the old methods is observable in most schools. Mr. Stansbie has found at the Birmingham Municipal Technical School that students desire only so much practical instruction as will give them an insight into the properties of the metals in which they are interested. Several special courses were gradually developed to meet the requirements of the various metal trades, and this book is put together from the laboratory notes of these courses. It offers sufficient scope for practical work in general metallurgy extending over the evenings of two years and leading up to the higher stages.

There is little in this admirable little book to which exception can be taken. It is a good piece of work, and will be very useful to teachers and students of evening technical classes, for whom it is primarily intended. Experiments are described on fuel, refractory materials, slags, fluxes, the formation and reduction of oxides and sulphides, and on the common metals. The last chapter describes the assay of gold and silver. The section on mechanical testing is particularly well done. If the student has previously passed through a course in elementary chemistry, he will find no difficulty in understanding the experimental work which he is asked to do.

An Introduction to Ethics for Training Colleges. By G. A. Johnston. Pp. x+254. (London: Macmillan and Co., Ltd., 1915.) Price 3s. net.

MORALITY of some sort, from the most ideal to the mere "reach-me-down" variety, has been indirectly taught in schools ever since schools became an institution. But, like the morality which is taught by all experience, to the primitive as well as to the civilised member of society, such instruction is founded in group-morality, which varies with climate, epoch, and other phases of environment. The various systems of theological morality are not to be excluded from the genus of group. When an attempt is made towards absolutism, whether by the *a priori* or the comparative method, we have ethical "science," the "moral philosophy" of European mental tradition. Ethics is actually a subject in French schools, a fact probably due to the logical bias of the French intellect. There is also a tendency now towards a moral *entente* between the different interests and racial features of the world.

Mr. G. A. Johnston's very complete little volume, designed for those who will teach in elementary schools, aims very sensibly at a psychological answer to the instructional problem as it is presented to-day. Every moral influence

of our civilisation is evaluated into simple terms by means of proved psychological conclusions.

But the whole social organism is one, and the influence of the school is only one factor; whether with rich or with poor, the home and the "street" have a majority influence.

The subject is all-important for the future of a race, but the intrinsic character of the race always supervenes unless and until acquired characters become transmissible.

A. E. CRAWLEY.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Organisation of Science.

SIR WILLIAM CROOKES hit the nail on the head when he said that the nation's attitude towards science is "largely due to the popular idea that science is a kind of hobby" (NATURE, December 2, 1915); and "F.R.S." directed the point of it when he said:—"What else can the general public do while men of science, in dealing with one another, generally act upon the principle that scientific investigation is a hobby for which facilities are required, not payment?" (NATURE, December 23, 1915). There is in this a distinct dereliction of duty, both by the public and by men of science. Science is not an amusement, but the most important of industries; and it is a premier obligation, of the public, of Government, and of men of science themselves, to advance it by every means in their power. Now what is the truth? Of all the occupations which individual men can possibly follow, the serious investigation of nature is the most profitable to the world at large—and the least profitable to the person who undertakes it. The result, controlled by ordinary economic laws, is that very few persons indeed ever do really engage in it, and if they do they suffer in consequence.

There is, of course, much scientific dabbling being done—precisely as a hobby; but as I take it, what may be called high science has for its end, not the mere recording of isolated observations, of plausible speculations, and of interesting curiosities, but the solution of difficult problems. Petty science is one thing; high science is another. Petty science is often extremely useful, and even occasionally leads to discoveries of the first importance; but the general advancement of our knowledge of nature depends upon the indefatigable, the laborious, and often the unavailing, search for solutions. It is precisely this last and greatest kind of effort which the hobby idea renders almost impossible—except perhaps for a few comparatively wealthy persons.

Consider, for example, the case of the dysentery problem. One form of this disease was found more than thirty years ago to be caused by certain amœbæ. Since then innumerable petty papers have been written on this subject, giving the results of a few weeks' or months' work, scattered observations, brilliant speculations, and beautiful coloured pictures. But even to-day we do not know how these organisms enter our bodies, and many questions which are fundamental as regards both treatment and prevention remain unanswered. The result is that thousands if not hundreds of thousands of persons die annually from a most painful disease; that our armies suffer in the field; and that the taxpayer is forced to expend large sums of money, a tithe of which would probably have solved the problem if it had been expended on proper research. But certain bodies which disburse small doles for so-called scientific research will hold up their hands in horror, and will say, "We have given such-and-such sums; we have paid so-and-so's salary; we have provided laboratories and microscopes here and there." So they have; but the result has been almost nil, because no individual man capable of solving the difficult problem has set his intellect to the task. Supposing that such a man exists, why should he set himself to the task? Should he give up his medical practice, or his professorship, or his leisure, to undertake a difficult inquiry which might prove fruitless in the end, just because a Government grant will provide him with apparatus and possibly a laboratory assistant? Personally, I think that such a man would not be likely to possess the capacity to solve any problem.

We may acknowledge with thanks that the nation does appear to be wakening to the necessity for assisting science; but it has not yet awakened to the fundamental issue—namely, that it must pay for work actually done—for results actually achieved—and not only for the expenses of research students and of professors who wish to indulge their "hobbies." This is the proper and most economical way to encourage science. For example, suppose that some person has solved, after years of toil, the dysentery problem, what would he receive for it? He would almost certainly lose his medical practice (as Edward Jenner did), much of his work would be pirated, he would be hampered at every turn by jealousies, and the only reward which he would be likely to receive might be a knighthood (which is the gift of the King and not of the country).

Men of science are themselves mostly to blame for this state of things. They show no solid front and have no courage in enforcing their demands. Besides this, there are many of them who actually make a cult of pretending that scientific work should be gratuitous. They are themselves too noble to accept payment; but I observe that few of these gentlemen have ever done important scientific work, but that, on the other hand, they are always first in the field when lucrative appointments are going. Indeed, quite a profession has grown up—that of persuading other men to do gratuitous scientific work for Government departments and for the public; and our grateful Governments respond at once by giving these people honours and lucrative posts, which they too often withhold from the men who have actually done the investigations.

Our learned societies are not less to blame Although they profess to encourage science in every way, they do nothing, or almost nothing, for the workers. What efforts have they made to remedy the innumerable abuses now existing in connection with science—the wretched salaries without pensions, the uncertain tenure of office, the misappropriation of appointments, the piracies, the farming out of scientific men by certain institutions for their own profit, and a dozen others? Indeed many of these societies do themselves lead the way in perpetuating such abuses. One of their grossest faults is to obtain gratuitous scientific work from their members for the advantage of Government departments and private institutions—thus, to speak plainly, acting as touts for the departments referred to, and at the same time depriving their expert members of the emoluments which they should receive for

their work or advice. What wonder, then, that the public, which sees through this kind of thing, should tend to despise, not only scientific men, but science itself?

It is idle to disguise the fact that recent events have filled most educated persons with a sense of extreme resentment against the administration of this country —a resentment which I have heard expressed by numbers of persons—civilians and soldiers. It is felt by many (and I am one of them) that we live under the rule of the invertebrates. The people who administer the country are not the best, the most vigorous, and the most sagacious of men. They are too often the time-servers and the mediocrities. The maladministration of scientific affairs is only one of the many forms of maladministration; but, on the whole, I think it is perhaps the most important form, because it gives to the mind of the whole nation a lower, a meaner, and a thoroughly sentimental and unpractical turn. For more than half a century before the war England has ceased to be an intellectual nation; the public at large has remained indifferent to science, art, literature, invention, and all the great intellectual pursuits, and has given itself up to game-playing, party politics, faddism, and a debased drama. We are now paying the penalty, and, if I do not mistake, will have to pay a heavier one before the end. If we have produced great men their names are unknown to the multitude, while the wire-pullers, the sentimentalists, and the hypocrites sit on high. That is my own summing up of the British nation of to-day—and I know that many agree with me. I am also of opinion that when our soldiers return from this war there will be something very like a revolution against the class of men who at present misgovern us in almost everything.

Sir William Crookes suggests a Ministry of Science and representation of science on the Privy Council. But in the light of our present experience are these likely to help us in any way? The Board of Education was appointed partly for this purpose, and what does it do for the worker? It has formulated a contributory pension scheme, but I believe nothing else. The able editorials in NATURE of November 24 and December 2, 1915, well define the position of science in this country to-day; but no reform is likely to be effected so long as men of science themselves do not insist upon it. What is required is a small association of strong men banded together for the express purpose of forcing the pace without fear or favour, and in spite of twaddlers who now paralyse all efforts at improvement. I would suggest at once the following programme:—

(1) Direct payment by the State for non-remunerative scientific work which has been of benefit to the public at large.

(2) Invariable payment by Government departments and public bodies for all scientific expert advice or assistance whatever.

(3) No issue of Government grants for expenses of researches without a fixed payment of, say, 50 per cent. to the workers themselves for their expenditure of time on the work.

(4) Control by the State over the sweating system now employed by universities and numerous public bodies in connection with scientific workers of all kinds.

Sir William Crookes thinks that our national attitude towards science "can only be rectified slowly, step by step." But war is a rapid arbiter, and the sword does not wait for the armour to be girded on. If I mistake not, we have not much time left for repentance. RONALD ROSS.

January 3.

Germany's Supplies of Nitric Acid.

AN article in the *Times* of January 6 deals with the resources in Germany for producing nitric acid. Formerly, the major part of the world's supply of nitrates came from the *caliche* beds on the west of the Andes, but of recent years, as is well known, nitric acid and nitrates have been manufactured by the electric process of Birkeland and Eyde in various parts of Norway. Franck and Caro, some years ago, introduced a process whereby ammonia can be produced from calcium carbide, after conversion into calcium cyanamide. The Ostwald-Kaiser process of partially oxidising ammonia by passing it along with air over platinum or other contact substances, afforded a practical means of producing cheap nitric acid. Then the discovery of Haber and Le Rossignol, that nitrogen and hydrogen could be combined in presence of contact agents under high pressure, and at moderate temperatures, made it possible to synthesise ammonia more cheaply than it could be obtained by recovery from gasworks liquors.

It is understood that the German Government subsidised the Badische factory to the extent of 100 million marks at the beginning of the war, so that no shortage in their supplies should occur. They claim to be producing sulphate of ammonium, according to Mr. D. Milne Watson, at the rate of 300,000 tons a year, and it is not impossible, provided they can get sufficient sulphuric acid. Mr. A. E. Barton, who has just returned from a visit to Norway and Sweden, learned that the increase in the Badische Company's output of ammonium sulphate was 200,000 tons; they had formerly manufactured 150,000 tons a year. Plant of 10,000 h.p. is being erected, too, in Westphalia, to produce ammonia by the carbide process; the result is expected to be the production of 200,000 tons of concentrated nitric acid a year. Other two works, one in Bavaria, and the other near Cologne, produce between them 45,000 tons of cyanamide.

Had our Government taken the steps which were urged upon them in August, 1914, to prevent Chile saltpetre from entering Germany, in all probability there would have been a shortage of nitric acid in Germany. That shortage is now not likely to occur.

W. R.

National Technical Training.

WITH reference to the recent leading articles dealing with the position of science and industry in this country, attention may usefully be directed to the system under which the work of the smaller technical schools is conducted.

At present it is generally admitted that our workpeople are not very scientific, and their trades unions do not appear to realise how much might be done if the various industries had colleges of their own. The only chance a workman has therefore of learning the technical portion of his business is by attending evening classes at the smaller technical colleges, and it is with these schools I would like to deal, since the subject is now of considerable importance.

At most of these places so many subjects are taught that they resemble museums of applied education more than anything else, and the principals in charge of them, and the inspectors who frequently inspect them, have generally no knowledge of *technical* work, or *business* experience. Why there are so many inspectors nobody knows, or what becomes of their reports. Further, the old system of examination has been given up, and "student hours" are made such a fetish, that I have seen classes opened and closed as many as seven times during a session; closed when one

out of six students failed to appear, reopened again later.

The London County Council has recently tried to centralise its system of teaching, and heads of departments find themselves dispensed with after perhaps eight years' hard work. This is a serious state of matters, as it shakes one's confidence in technical teaching as a profession. In many schools there is no pension.

From the nature of their appointments the teachers are not allowed to do outside work, yet specialists are sometimes engaged to lecture because they have outside experience. If more security was offered to teachers, and if they could keep in touch with the outside world, workpeople would go to their classes. Under the present system large sums have to be spent advertising these schools which should not require it. There has been a great deal too much of the village schoolmaster attitude, and it is surely a mistake to allow technical work to fall into the hands of such people.

W. H. F. MURDOCH.

Westerlea, Millhill.

WAR ECONOMY AND AGRICULTURAL EDUCATION.

THE necessity for economy is having the interesting result of showing the relative values attached by county councils to the things over which they have control. When economy becomes necessary one first of all cuts off the things that do not matter, so as to keep hold of those that count.

The present attitude of the county councils towards agricultural education affords a case in point. Considerable sums of money, known as the "whisky money," have been placed by the Treasury in the hands of the county councils for purposes of technical education. Over the spending of the money the taxpayer retained no adequate control, so that the county council can, if it likes, simply apply this money to the reduction of the local rates. Most county councils, of course, have not taken this narrow view, but have conscientiously fostered technical education, with the result that a number of good agricultural colleges and departments of universities are now in existence doing very useful work. But a few have thought of little more than relieving the rates, and, while this course is undoubtedly popular with a certain section of the community, it cannot be described as wise.

A recent instance is furnished by the action of the East Sussex County Council in closing the Uckfield Agricultural College. By a curious anomaly Sussex is divided for educational purposes into two areas, each under wholly distinct administration. East Sussex has tried to run elementary education and higher education on its own account, and has not co-operated with any of its neighbours in the matter. It had an agricultural college at Uckfield which admittedly did useful work: the number of students was well maintained, and grants were earned from the Board of Agriculture. As a war economy the college has been closed. There is, we understand, no suggestion of inefficiency on the part of the staff: had that existed of course the matter would have been different. Nor was there any widespread demand on the part of East Sussex farmers that their sons should be saved from the possibility of receiving agricultural education. The whole thing appears to have been done by the education committee without reference to anyone, and without any other reason than economy.

Now this action is very serious, more indeed than appears at first sight. An agricultural college is not simply a building—which is at least permanent; it comprises also fields, crops, livestock, etc., which are not permanent, and, once sold into other hands, can scarcely be got together again. To restart the college would be a difficult business. The committee, in short, for the sake of a small saving now, is piling up difficulties in the way of any future attempts at agricultural education that may be made by more enlightened successors. If the college had been paid for exclusively by the East Sussex ratepayers we might leave the matter in their hands. But it has not: the whole State has paid a good deal. The very important question is raised whether an education committee of a county council ought to have the power to close an institution subsidised by the State, and whether the State ought not to have the power of veto.

We believe that East Sussex is the only place where an agricultural college has been closed by the county council, but in another instance—again a case where a county council is split into sections for purposes of education—the expert agricultural organiser has been dismissed on the score, not of inefficiency, which would have been a satisfactory reason had it existed, but of economy. This section of the county will save the organiser's salary—which was not very great—but every agricultural college has mentally noted the fact, and it is scarcely likely that they would recommend competent students to enter the service of that particular body in future. Again the State ought to have the power of veto, for here also it has provided part at least of the funds.

It appears to be only in cases where a county is split up into sections that these unfortunate incidents occur. In larger areas larger ideas prevail, and the further question arises whether it is right that education, which is essentially a matter for the future—and in which, therefore, the large idea is indispensable—should be in the hands of a small committee representing a small area, and we fear animated by rather small ideas? It would seem that better results could be obtained by working over larger areas, for there alone is the hope of finding enough men with ideas and ideals to serve on the committees, and to protect the lecturers and organisers who are honestly trying to do their best for the agricultural community.

THE HISTORY OF BABYLON.[1]

PROF. L. W. KING'S "History of Babylon" appears at the moment when, owing to the folly, ambition, and half-religious, half-patriotic fanaticism of a small, intelligent, but absolutely immoral clique that has arrogated to itself the government of the Turkish Empire, England finds herself at war with her old allies of the Crimea and friends of 1878, and British soldiers are contending with the hosts of the Padishah on the ancient plains of Babylonia. It is a day which many Englishmen and many Turks had never thought to see; but if the most energetic men in Turkey happen to be thoroughly evil, and choose wilfully to make friends rather with the militarism of Prussia than with the liberalism of England, it is one that cannot be helped. *Kismet!* it was so written, say those Turks who would still be our friends: the issue is in the hands of Allah. As Babylon fell, so will Turkey. But the battle of Ctesiphon, fought not so far away from Babylon's ruins, shows us that it is no easy task that Turkey, sold to Prussia, has forced us to undertake.

Prof. King tells us the ancient history of the country in which our men and their Indian comrades are now struggling with the hardy peasant-soldiers of Anatolia, the descendants of those Hittites who long ago sacked Babylon and brought the dynasty of Hammurabi to its end. He takes us from the foundation of the Semitic kingdom of Babylon down to the conquest by Alexander, through a period of some two thousand years. The earlier history of Babylonia under its Sumerian inhabitants has already been told by him in his "History of Sumer and Akkad," the first of a trilogy of which the "History of Babylon" is the second, and a forthcoming "History of Assyria" will be the third volume. The book is of the same format and has the same fine appearance as its predecessor, and is printed and produced in the same good style, which reflects great credit on the publishers.

Prof. King starts by describing the great city itself, as it is now shown to us excavated by the labours of the German archæologists, led by Prof. Koldewey, who for some years past have been digging up its remains. We see the great *ziggurat* or Temple of Bel-Marduk (the Tower of Babel itself, that so struck the imagination of the Hebrews in their captivity that they enshrined it in their oldest legends), the broad street of Aiburshabu, the splendours of the Gate of Ishtar with its reliefs of many-coloured ceramic enamel; all the ruined glories of Babylon the great, that Nebuchadnezzar the king made so mighty and splendid; the courts of Jamshyd, that now the lion and the lizard keep.

We are then taken through certain chronological problems that have lately arisen to be discussed, and must be settled before we can settle down to the course of the history itself. These problems are largely concerned with the determination of the date of Hammurabi, the great Semitic king and law-giver, and of his dynasty. In the light of new evidence lately brought to light, Prof. King revises the date he before considered probable, and shows us that we can now date Hammurabi with practical certainty to about 2100 B.C., a century and a half earlier than was before considered possible.

We then are told all that is known (and it is a great deal) of the great king himself and of the age in which he lived, down to the extinction of his dynasty by the Hittites from Asia Minor. The long period of the Kassite kings, Indo-European conquerors from northern Persia, now follows, Babylon first comes into contact with Egypt, and the secular struggle with her daughter and enemy Assyria begins, until finally Babylon shrinks into a mere unwilling dependency of Nineveh that is finally destroyed by the ruthless Sennacherib, a worthy model for the destroyers of Louvain and their Young-Turk friends. The *beau geste* of the more civilised Esarhaddon follows, and Babylon is restored, to take her revenge on her oppressor, Nineveh, when the latter fell amid the rejoicings and execrations of the nations, as we hope some day Berlin will also fall. For, as Prof. J. L. Myres has already shown in his brilliant little book, "The Dawn of History," published two years before the war, it is no fortuitous resemblance that modern Germany bears to ancient Assyria.

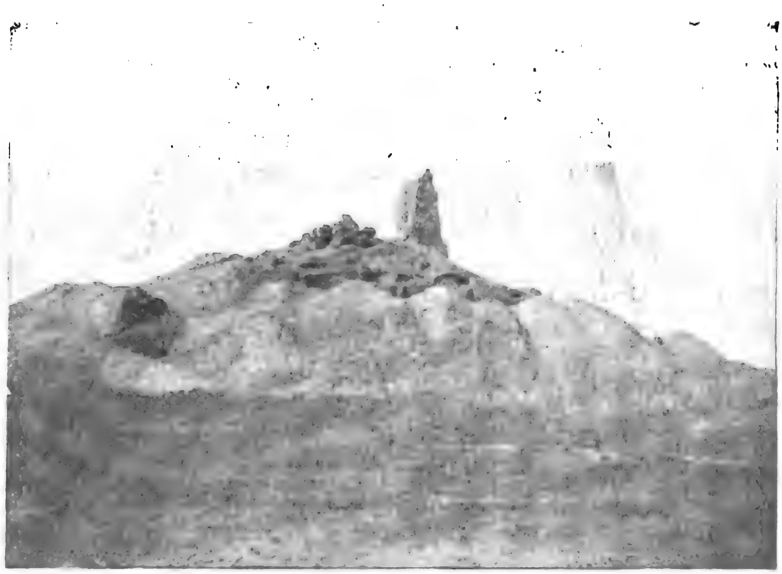

FIG. 1.—The Temple-Tower of E-zida at Borsippa. From "A History of Babylon."

[1] "A History of Babylon from the Foundation of the Monarchy to the Persian Conquest." By Prof. L. W. King. Pp. xxiii+340. (London: Chatto and Windus, 1915.) Price 18s. net.

Yet Babylon showed herself little better in prosperity than Assyria had been. Nebuchadnezzar made Babylon splendid, but he also carried the Jews away captive like any Sennacherib. Babylon also fell, and a saner conqueror, Cyrus, removed from her finally all temptation to exercise power and dominion, while at the same time treating her with humanity. The religion of Zoroaster had brought a better *ethos* into the Middle East than had ever been known before.

With the end of the Persian dominion and the coming of Twohamed Alexander, Prof. King's history closes. He adds in conclusion a most interesting chapter entitled "Greece, Palestine, and Babylon: an Estimate of Cultural Influence." Readers of Dr. Farnell's most interesting book, "Greece and Babylon," will be glad to read Prof. King's contribution to the discussion of this subject. The priest of Saïs who talked to Herodotus knew much more than he told Herodotus. But one hopes that Prof. King will pursue this subject further, some time, than he does in this book.

FIG. 2.—The Lion of Babylon on the Kasr Mound. From "A History of Babylon."

In this chapter Prof. King soon goes on to a matter that has agitated archæological circles very considerably during the last decade: the German "Astralmythen" theory and its marvellous ramifications and developments. In measured language he points out, following the Dutch scholar, Dr. Kugler, the weakness and uselessness of this latest shower of chips from a German workshop. It is curious to see how magnificent German work can often be, and how extraordinarily absurd it often is. It is like the national mind: sublime and ridiculous at once; and when ridiculous, absolutely sublime in its absurdity. No Englishman can ever talk such nonsense as a German can and will, if he tends that way. It was no Englishman who invented the Sun-myth and the Dawn-maidens, but a German of Germans, Max Müller. It is the British sense of humour that saves us from this sort of thing. Gladstone accepted Max Müller, but Gladstone was a *dilettante* and had no sense of humour, besides. True Britons, sceptics by blood and users of that irony which is one of our most national characteristics, always derided Max Müller and his Dawn-maidens, and now they must rise again to laugh out of court the new revival of them which Germany has imagined in the "Astralmythen" theory. For this is nothing but Maxmüllerism all over again, though it rises this time from a Babylonian, not an Indian source. For the Astral-mythologists, not only acknowledged myth, but even ordinary tradition, becomes Babylonian and astral in its origin, whether it is a case of the five kings hiding themselves from Joshua in the cave of Makkedah or the voyage of Odysseus to Scheria. Everything is an astral *motif*: the phraseology of Wagner is brought in, of course. If five kings hide in a cave: it is the "Descent into the Underworld" *motif*. If anybody goes into a cave or hides anywhere: it is the same *motif*. Ishtar and Tammuz are there. Doubtless then Prince Charlie in the '45 was Tammuz, and Flora Macdonald was Ishtar. We are scarcely jesting: Dr. Jeremias, one of the high-priests of this theory, is almost capable of saying so. Taking a realm of history doubtless more familiar to Dr. Jeremias, Enzio, too, King Heinz, who was imprisoned at Bologna, is obviously Tammuz, and the noble lady of Bologna who comforted him in his captivity is no less obviously Ishtar. And his long fair hair (*"i capelli biondi alla cintura"*) that betrayed him by falling out of the basket in which "Ishtar" was trying to get this medieval German "Tammuz" smuggled out of Bologna; that would be just a sunbeam, no doubt. Dr. Kugler has shown the absurdity of the theory by demonstrating that the life of Louis XI. of France, for instance, can be made out to be full of solar and astral *motifs*.

Then there is the "Bel and the Dragon" *motif*. If we apply it to the myths of Canossa and Jena, two myths highly interesting to Germans, we should have little difficulty in showing that Pope Gregory and Napoleon were simply forms of Bel, and that the Dragon was in the first case the Hohenstaufen, in the second the Hohenzollern. And that were *Majestätsbeleidigung* and enough to hang us all, every mother's son: for there is no more fearful wild-fowl than your Hohenzollern living!

Prof. King quietly and temperately points out the absurdities of the astral enthusiasts, with, we think, a quiet smile of amusement at their extravagance, especially when he has the malicious

pleasure of pointing out that their chief hierophant, the late Prof. Winckler, got most of his astronomy, on which he based his theory, all wrong. His criticism is all the more effective for the studious moderation of his language.

So the book ends, with the final abolition of an absurdity comparable only to that other absurdity, Winckler's *Musri* theory, which was first exploded in the columns of NATURE some years ago (September 25, 1902). The said theory, so far as we can see, is not even mentioned by Prof. King in his book, so dead is it and buried.

So critical common-sense triumphs over nonsense, and true scientific knowledge increases. And Prof. King's book is a landmark of such progress in Babylonian studies, besides giving the general reader an admirable presentment of a most interesting period of ancient history. Its illustrations are good and well chosen: we show two of the photographs of the ruins at Borsippa and Babylon. H. H.

DR. BENJAMIN WILLIAMSON, F.R.S.

THERE has just died at his residence in Dublin Dr. Benjamin Williamson, F.R.S., who was for sixty-three years a fellow of Trinity College. Dr. Williamson was born at Mallow, in the county of Cork, in 1827, and entered Trinity College from Kilkenny College in 1843. In 1852 he was elected to a fellowship of Trinity College, but owing to the stagnation of promotion among the fellows, due to the abolition of the obligations of celibacy and of taking Holy Orders, he did not become a tutor until many years afterwards. The intervening years were not, however, wasted, and Williamson quickly earned a considerable local reputation as a lecturer who was able to estimate the capacity of his hearers and did not endeavour to teach them what they were unable to learn. In 1872 he published his first work, a "Treatise on the Differential Calculus," which was followed in 1874 by his "Integral Calculus," both of which have run into many editions and have been used all over the English-speaking world. In 1879 he was elected a fellow of the Royal Society, and in 1884 he became professor of natural philosophy in Trinity College. In the latter year he published, along with Dr. Tarleton, a treatise on dynamics, and in 1893 appeared his last publication, "The Mathematical Theory of Stress and Strain." The articles "Infinitesimal Calculus," "Maclaurin," and "Variations, Calculus of," in the ninth edition of the "Encyclopædia Britannica" are also due to him.

Williamson's personality was one of the most delightful, and his rooms in college in the 'eighties were the place of hospitality which many an Englishman, sent for his sins to govern Ireland, remembered with pleasure. The human side of Williamson was always turned towards his fellows, and his mind was always ready to receive suggestions on which his generosity could act. When, in 1897, he became a member of the governing body of the college, his ripe judgment and his wide acquaintance began at once to be appreciated by his colleagues. The magnificent new laboratories for physics and botany are a portion only of the fruit of his efforts. In matters of learning he was free from prejudice, and proposals for the founding of new chairs or the improving of old found in him always a ready support. Until a couple of years ago he filled with great dignity the honourable office of vice-provost of the college, and it was only with the greatest reluctance that he was compelled by weakness of the body to abandon cares from which his mind did not recoil. The fate of those who by living too long outlive all their friends was not his, for his genial presence and the freshness of his mind made friends for him everywhere. His death is mourned by all who knew him. S. B. K.

COUNT SOLMS-LAUBACH, For.Mem.R.S.

BY the death of Hermann, Graf zu Solms-Laubach, on November 25, 1915, Germany has lost the most distinguished of her botanists and the world of science one of its most impressive figures. The sad news was communicated to this country through the Swedish palæontologist, Prof. Nathorst, of Stockholm.

Count Solms was born on December 23, 1842, and had thus nearly completed his seventy-third year. He came of one of the most ancient of German families, who were sovereign in their own domains down to the year 1806. He himself devoted his life wholly to science, holding the professorship of botany, first at Göttingen and afterwards at Strasburg. He resigned the latter post a few years ago, but continued to live in the town, surrounded by his university friends.

His work extended to every department of botany. Beginning with an important series of researches on parasitic phanerogams, he subsequently monographed several natural orders, including the screw-pines. His interest in the morphology of flowering plants continued in later years; in 1900 he described the remarkable Crucifer, *Capsella Hegeri,* with indehiscent fruits, regarding it as a mutant of the common *C. Bursa pastoris.* He was always interested in variation, and carried out important investigations on the history of cultivated plants, such as the fig, the papaw, wheat, tulips, and strawberries.

In embryology, he showed that in certain monocotyledons the growing point of the embryo is terminal, as in dicotyledons.

In addition to the flowering plants, his systematic researches extended to every class of cryptogams. One of his most remarkable works in this field is his monograph of the Acetabulariaceæ, a family of calcareous Algæ with an ancient fossil history. This was published in 1895 in the Transactions of the Linnean Society, and was his only paper written in English. His book on the "Principles of Plant Geography" (1905) treats in an original manner of the leading conceptions in this great subject.

Perhaps the most important of all his work was that on fossil botany. Solms was an intimate friend of Williamson's, and appreciated his writings and his collection as no one else did at the time. He wrote the obituary notice of Williamson, published in NATURE for September 5, 1905, a worthy tribute to his old friend's work.

Solms's "Einleitung in die Paläophytologie," published in 1887 and translated for the Oxford Press in 1892, was of the utmost importance in bringing home to botanists the value and significance of the geological record as affecting plants.

Among his special papers may be mentioned his brilliant work on the Isle of Wight fossil, *Bennettites Gibsonianus* (1890; translated 1891) the type of the Mesozoic Cycadophytes, on the Cycadofilices Protopitys, Medullosa, etc.; on the Devonian and Lower Carboniferous plants of Germany, and on Psaronius. In a quite recent paper on the last-mentioned group he elucidated, for the first time, the true nature of the root-zone. The remarkable recent progress of Palæobotany is in a great degree due to his researches.

Count Solms became a foreign member of the Linnean Society in 1887, of the Royal Society in 1902, and of the Geological Society in 1906. He received the gold medal of the Linnean Society in 1911, and was made a Sc.D. of the University of Cambridge at the Darwin Celebration in 1909.

He had a thorough knowledge of this country, and was a good friend of the English; many who knew him personally were deeply attached to him. He was always intensely averse to the idea of a rupture between his country and ours. We have no record of his feelings after war broke out, but must remember that he was a patriotic German, who had served in the war of 1870.

He was a striking and original personality, of rare intellectual power, and a born leader of men.

D. H. S.

NOTES.

IN the course of a debate on co-operative fiscal and economic policy, in the House of Commons on Monday, reference was made to the fact that some industries were almost entirely in German hands before the war broke out. Mr. Runciman, President of the Board of Trade, made the following remarks upon this subject towards the end of the debate:—We have been placed under grave disabilities owing to the fact that optical glass was made almost entirely in Austria and Germany and so little of it was made in this country. It was one of the first articles in which the Board of Trade took an interest in the autumn of 1914. We gathered together all the information we could on the subject of optical glass. We gave every possible assistance to those in this country who were prepared to undertake its manufacture, and already they are producing optical glass which never before had been equalled here. We trust that the monopoly which was held by Germany before the war will never go back to her. In chemicals we have produced to a remarkable degree a large number of articles which before the war were almost entirely in German hands. Take the case of dyes. Not only the company which by leave of this House was assisted out of our national funds, but also other concerns have produced an enormous amount of dyes during the war. Electrical apparatus in some particulars was almost entirely in German hands. Every one of these articles, glass, chemicals, dyes, electrical apparatus, and I could name about a dozen others, were industries of vast importance not only to us as a great commercial country, but as a fighting country. Without these glass articles, without some of the porcelain articles which are essential for electrical construction, without the best type of magneto, without some of the best of our chemicals, and without a great range of dyes, which used to be manufactured in Germany, we were placed at a great disadvantage. Never again should that happen. This is more than a mere matter of competing with Germany. It ought to be part of our national organisation. Government departments can do a great deal, and I believe they ought to do more, but without the personal ability, without the training, skill, and industry of the individual, nothing can be done by Government departments. I therefore put down as one of the first necessities of this country, if she is to hold her own during times of war and when war is over, that we must improve our research methods, the education of our people, and the training of our young men. We should not attempt to economise on the money we now spend on technical colleges and modern appliances. There are other directions in which we can cut down expenditure with less national damage.

PROF. W. H. PERKIN, F.R.S., professor of chemistry at the University of Oxford, has accepted the post of head of the research department of British Dyes, Limited. He has also accepted the chairmanship of the Advisory Council of that company, in the place made vacant by the death of the late Prof. Raphael Meldola, F.R.S. The board of British Dyes, Limited, expresses special gratification that it has been able to secure the services of Prof. Perkin, who occupies a position of unique distinction as an organic chemist, and has done much valuable research work in regard to problems arising in connection with the manufacture of dyes. He is a son of the late Sir William Perkin, who was the founder of the coal-tar colour industry.

THE council of the Geological Society of London has this year made the following awards of medals and funds:—Wollaston medal, Dr. A. P. Karpinsky (Petrograd); Murchison medal, Dr. R. Kidston, F.R.S. (Stirling); Lyell medal, Dr. C. W. Andrews, F.R.S. (Natural History Museum, London); Wollaston fund, Mr. W. B. Wright (Geological Survey of Ireland); Murchison fund, Mr. G. W. Tyrrell (Glasgow University); Lyell fund, Messrs. M. A. C. Hinton and A. S. Kennard.

THE late Prof. Meldola left property of the value of 34,956*l.*, the net personalty being 33,767*l.* He bequeathed his entomological collection and cabinets to the Hope Museum, Oxford. After certain legacies have been paid, the residue of the property is left to the testator's wife for life, and then for his children,

and on failure of issue, 500*l.* each is to be paid to the Royal Society, the Chemical Society, the Entomological Society, and the Institute of Chemistry of Great Britain and Ireland.

THE Government of India has created a special appointment in research for Prof. J. C. Bose, in recognition of his important contributions in biophysics. Dr. Bose is now engaged in completing his new work on "Experimental Phyto-dynamics," which will contain a detailed course of new methods and instrumental appliances for the advanced research on plant-irritability, the specimens of plants chosen being those available in Europe and America. The Government of India has also placed at his disposal experimental stations in the hills, where climatic conditions are similar to those in the West. The faculty of Presidency College, Calcutta, has appointed Dr. Bose professor emeritus, *honoris causâ*, for the benefits conferred by him on the college by his services for the last thirty-one years.

MISS MARGARET HARWOOD, formerly at Harvard Observatory, and, by annual award, a fellow of the Nantucket Maria Mitchell Association, 1912–16, has been appointed for an indefinite term a fellow of this association and director of its observatory. Miss Harwood is at present studying at the University of California. Her new year at the Nantucket Observatory will begin on June 15 next. Many women teach astronomy successfully, but few openings exist for women to do research work, and a majority of the fellowship committee recommended Miss Harwood's permanent appointment, to ensure to a woman in every way prepared this unusual privilege, free from academic control. The Maria Mitchell memorial fellowship at Harvard Observatory has been awarded for 1916–17 to Miss Susan Raymond. The value of the fellowship is 100*l.*

THE Journal of the Institution of Electrical Engineers for December 15, 1915, contains a report of an interesting presentation of original Faraday papers made to the institution by Mr. D. J. Blaikley, whose wife is a niece of Faraday's. Her sister, Miss Jane Barnard, lived for several years with Faraday and his wife as a daughter of the house. She died in 1911, and left these books and papers to Mr. Blaikley to dispose of under certain conditions. They include Faraday's journal of the Continental voyage which he undertook, at the age of twenty-two, as an assistant to Sir Humphry Davy—the voyage which, Prof. Silvanus Thompson said, in proposing the vote of thanks to Mr. Blaikley, "transformed Faraday from being little more than a bookbinder's apprentice and laboratory assistant of a great chemist, into a man who could speak and think and work scientifically."

THE Rome correspondent of the *Times* announces the death, at eighty-three years of age, of Dr. Guido Baccelli, professor of clinical medicine in the University of Rome. Dr. Baccelli took a very active part in Italian politics: he was four times Minister of Public Instruction, and once Minister of Agriculture, Industry, and Commerce.

AMONG the victims of the *Persia* outrage was Miss Elizabeth Stephens Impey, M.B., Ch.B., who was on her way to take up her post as medical officer at the Dufferin Hospital, Lahore. Miss Impey, who was an all-round athlete, was the first woman to be president of the Guild of Undergraduates of Birmingham University.

THE death is reported of Mr. T. L. Willson, of Ottawa, Canada, who was awarded the McCharles prize by Toronto University in 1909 for his various discoveries. His manufacture of calcium carbide had a most important industrial influence. His inventions were principally concerned with acetylene gas and carbide, and included the Willson acetylene-gas buoys and the Willson gas beacons. He was formerly president of the International Signal Company of Ottawa. At the time of his death Mr. Willson was working out an enterprise in Newfoundland for the production of an artificial fertiliser.

DR. R. A. WITTHAUS, a prominent American toxicologist, died recently at his home in New York at the age of sixty-nine. He had successively occupied chairs of chemistry at the University of Vermont, the University of Buffalo, and the medical college of Cornell University. He was best known as a "poison expert" in a number of sensational criminal trials. He was also the author of several manuals of chemistry, and had contributed largely to the literature of medical jurisprudence. Dr. Witthaus was a graduate in arts of Columbia University, and in medicine of New York University.

THE *Engineer* for January 7 records the death of Mr. Peter Whyte, which took place in Edinburgh on December 31. Mr. Whyte occupied the post of superintendent and engineer of Leith harbour and docks for thirty years, and retired two years ago. He was a member of the Institution of Civil Engineers, and was an authority in dock engineering and port management; he acted as advisory expert to the Government Commission charged with the taking over of the docks at Singapore. Papers on professional subjects were contributed by Mr. Whyte to the Royal Society of Arts, the Royal Society of Edinburgh, the Association of Municipal and County Engineers, and kindred bodies.

THE death has occurred, at the age of eighty, of Dr. D. G. Elliot, who shared with the late Prof. A. S. Bickmore the honour of being one of the two scientific founders of the American Museum of Natural History. His career as a zoological traveller and collector began when he was scarcely out of his boyhood, and continued until quite recent years. As late as 1909 he made a tour which included such diverse points as the second cataract of the Nile, Mandalay, Batavia, Hankow, and Mauna Loa. His expedition into the recesses of the Olympic Mountains in 1898 is said to have been the first penetration of that range by any naturalist. Dr. Elliot's outstanding work was his recently published "Review of the Primates." He was the author of many other books on zoological subjects and of hundreds of papers in scientific journals.

THE death is reported, in his eightieth year, of Dr. A. W. Wright, of Yale, who occupied the chair of molecular physics and chemistry in that University

from 1871 to 1887, and of experimental physics from 1887 to 1906. From 1883 to 1906 he was in charge of the Sloane physical laboratory at Yale, which was built under his supervision from his own plans. Earlier in his career he had been professor of physics and chemistry at Williams College, and a consulting specialist in the U.S. signal service. He was sent by the American Government to Colorado in 1878 to observe a total eclipse of the sun, and at that time made the first measurement of the polarisation of the solar corona. He was the first to observe the electric shadow in air, discovered and analysed gases in stony meteorites, and applied kathode discharge *in vacuo* to form metallic films for mirrors. Prof. Wright is said to have been the first American to obtain definite results with X-rays, and his papers upon the subject attracted wide attention.

By the death of Prof. F. W. Putnam, honorary director of the Peabody Museum of American Archæology and Ethnology, Harvard, news of which reached us only a few days ago, anthropology throughout the world has suffered a grievous loss. His interest in the subject began in 1857; in 1873 he was appointed first curator of the Peabody Museum, and in 1886 professor of American archæology and ethnology in Harvard University. His activity was shown in museum organisation rather than in field work, and under his control the great collections in his charge were systematically arranged and catalogued. In spite of his absorption in museum work, he found time to publish a large number of scientific papers, the anniversary volume presented to him in 1909 containing no fewer than four hundred titles. But it was by the encouragement of research and by his kindly sympathy with younger workers that his best work was done, and he will rank with Brinton and Powell as one of the founders of the American school of scientific ethnology.

THE death of Sir Frederic W. Hewitt on January 6 deprives us of one of our most prominent anæsthetists. Born in 1857, he graduated at Cambridge, receiving his medical training at St. George's Hospital. Hewitt specialised early in his career, and, becoming attached to a dental hospital, experimented with the combined use of oxygen and nitrous oxide. Bert had demonstrated its value, employing it under plus-pressure; more recently it had been used on the Continent at normal pressure, but Hewitt it was who by his ingenious apparatus introduced a practical method into this country. In the wider field of general anæsthetics he had done much most valuable work. In "Anæsthetics and their Administration," he focused his individual views. The book reveals the meticulous care of Hewitt's clinical observations. Indeed, few men worked harder or strove more whole-heartedly to advance our knowledge of anæsthetics. In his hospital appointments at the London Hospital, and afterwards at St. George's Hospital, as anæsthetist and lecturer, his teaching was highly and rightly appreciated. He was appointed anæsthetist to the late King, and received the M.V.O. for his personal services to that monarch. Later he held the same post to King George, and received a knighthood. Hewitt contributed some valuable articles to the transactions of medical societies and journals, notably one on the effect of posture on anæsthesia. He, always a most strenuous fighter, endeavoured to obtain legislation to protect patients from the dangers of unskilled persons using anæsthetics. On this subject he gave useful evidence before a Departmental Committee. Science and practice have lost much through his early death.

THE *Indian Journal of Medical Research* for October, 1915 (vol. iii., No. 2) contains a number of valuable papers. Lieut.-Col. Sutherland details notes on 2643 medico-legal cases, in which 6566 articles, suspected to be bloodstained, were examined. The method of examination was by the precipitin test, by which it is possible to determine the *kind* of blood, and by chemical, microscopical, and spectroscopical examinations. Major Grieg has noted the production of gall-stones in rabbits following intravenous inoculations of cholera-like vibrios. These observations may throw some light on the formation of gall-stones in the human subject, a lesion which is frequently observed in Calcutta.

A VERY interesting summary of the more striking of the Batrachia of the world, now living in the Gardens of the Zoological Society of New York, appears in *Zoologica*, vol. ii., No. 1, by Mr. Richard Deckert. The author gives the more important features of the life-history of each of the species described, supplementing his remarks with some most excellent photographs. His review is greatly enhanced in value by means of a coloured plate giving figures of some extraordinary harlequin frogs from tropical America. Two of these are of a brilliant scarlet, and one species has blue legs, forming a most striking contrast. A third species is of an emerald green, boldly marked with black. These frogs, which belong to the genus Dendrobates, are remarkable for the virulence of the poison secreted by the skin-glands, and some interesting notes on this subject find a place here.

AN ingenious attempt to demonstrate "a Tetrapteryx Stage in the Ancestry of Birds" has just been made by Mr. C. W. Beebee in *Zoologica*, vol. ii., No. 2. The author insists that the precocious and conspicuous development of the femoral tract in the pterylosis of nestling birds points conclusively to a stage in the development of the pro-aves when this tract was formed of large quill-like feathers, which, with similar feathers along the post-axial border of the fore-limb, afforded a parachute-like mechanism, comparable to the flying-membranes of flying-squirrels, and preceded true flight. The hypothetical restoration of this four-winged stage, which forms the frontispiece to his essay, is curiously like that which appeared in *Knowledge* in 1906, save that this lacked the "femoral wings." Mr. Beebee seeks to justify his hypothesis by an appeal to photographs of the remains of the Archæopteryx in the Berlin Museum. These, however, certainly seem to have been misinterpreted, for the feathers to which he evidently refers are those which invested the tibia. No one who has studied the original remains of this fossil would for a moment agree that these afford evidence for this "femoral tract."

THE pea-aphid (*Macrosiphum pisi*) is a well-known garden pest in this country and in Europe. In 1878 it appeared in the United States, where it has now become sufficiently important to form the subject of a paper by J. J. Davis (U.S. Dept. Agric., Bulletin 276). The species ranges westwards beyond the Mississippi valley, and is found in a few localities near the Pacific coast. Among several points of interest in this bulletin may be mentioned the fact that "oviparous females may be produced by either wingless or winged [virgin] females, and the same female may produce both viviparous and sexual forms alternately." It is not surprising that American syphid-flies and ladybirds prey upon the aphids, as their relations do in these countries, but the predaceous habits of a cecidomyid larva (*Aphidoletes meridionalis*), which feeds "upon the juices of the plant-louse till the latter is dead," are remarkable for a member of this gall-forming family.

IT is well known that during the last five years numerous specimens of the handsome European ground-beetle, *Calosoma sycophanta*, have been imported into the New England States that they may feed upon caterpillars of the gipsy moth (*Porthetria dispar*), itself a species introduced from Europe into North America. An account of the establishment of the Calosoma across the Atlantic, recently given by A. F. Burgess and C. W. Collins (U.S. Dept. Agric., Bulletin 251), contains some interesting details. A map shows how by natural extension and by fresh importations the beetle has spread its range north, south, and westwards from Boston; "it has already demonstrated that it is a very important factor in the control of the gipsy moth by natural enemies." Unfortunately, the beetle is not without "natural enemies" of its own in its new home, the most dangerous being that notorious American mammal, the skunk, the excrement of which in some localities consists chiefly of fragments of Calosoma.

THE widespread death and dying back of seedlings of sal (*Shorea robusta*) is a very common occurrence in the Indian sal forests. Mr. R. S. Hole, in the *Indian Forester*, vol. xli., No. 10, gives an account of his investigations into the matter, and finds that bad soil aeration and drought are the chief factors responsible for the failure of sal reproduction. Deficiency of oxygen owing to water-logging of the soil, and also some toxic substances possibly emanating from dead sal leaves, have been found to be definitely injurious, since in similar soil well drained and kept clear of leaves very good germination resulted. Practical recommendations for forest use are put forward as the result of experiments made in the Dehra Dun forests.

IN the Bulletin of the Department of Agriculture, Trinidad and Tobago, part v., vol. xiv., 1915, Mr. J. B. Roner, mycologist to the Board of Agriculture, contributes a paper on the Anthracnose of the mango, the disease caused by the fungus *Gloeosporium mangiferae*, which also attacks avocado pears, citrus trees, and many other plants. A description of the fungus as it affects the flowers, leaves, and fruit of the mango is given, and a plate of figures illustrates the appearance of attacked leaves and fruits. The beneficial results of spraying the trees during the blossoming period is fully described. A clean, and also a heavy, crop of fruit resulted in all cases. Another noticeable and valuable feature of the sprayed fruit is that it keeps much longer than unsprayed fruit. This was proved from consignments of mangoes sent to Kew and to the United States, and also from mangoes which which were kept in cold storage in Trinidad. The fruit reached England in splendid condition, and a number of fruits were not fully ripe at Kew twenty-two days after they had been picked in Trinidad.

THE inheritance of bearding and felting in wheat forms the subject of a paper by Mr. and Mrs. Howard in Memoirs of the Department of Agriculture of India, vol. vii., No. 8, and is a continuation of their earlier paper published in vol. v., 1912. Owing to the fact that heretofore wheat with short awns as well as those without beards have been described as beardless, controversy has arisen over the results of earlier workers. In the present work on Indian wheats, bearded crossed by beardless—as usually described—showed two different phenomena. In one series, F-1, plants were half bearded, and in the other only very short tips were present on the glumes, these differences being correlated with the beardless parent; in the first place the parent having tips to the glumes and in the second being quite beardless. The results are set out in detail and illustrated by a very clear series of plates. The inheritance of the felted character of the chaff continues the earlier work, but it is shown that two kinds of hairs may be present, long silky and much shorter hairs, which are inherited separately.

IN a pamphlet entitled "The Urgency of a Definite Forward Movement in the Study of the Active Principles of South African Plants" (Capetown: Townshend, Taylor and Snashall) Dr. C. F. Juritz again directs attention to the urgent necessity for a systematic study of South African plants from botanical, chemical, and physiological points of view. He deals with several examples of toxic or medicinally active drugs, and shows what progress has been made and in what directions further investigation is necessary. The appendix, which constitutes about one-half of the pamphlet, is both interesting and valuable. In addition to a bibliography of the subject, it contains a list of plants that so far have been examined, together with the constituents that have been isolated from each, and also a list of cases of poisoning or suspected poisoning by indigenous plants investigated in the Cape Government Laboratories. These two lists clearly support Dr. Juritz's plea, and leave no room for doubt that researches made with sufficient material, possibly following the method so successfully employed by Dr. Power and his collaborators, would yield scientific results of the greatest value.

SOME experiments on the physiology of indigo-yielding glucosides are described by Mr. F. R. Parnell in the Memoirs of the Department for Agriculture in India (Botanical Series, vol. vii., No. 5). An indigo-forming glucoside is present in the root and seed of both *Wrightia tinctoria*, Br., and *W. tomentosa*, R.

and S.; it is absent, however, from the leaves of the latter. The glucoside and its enzyme in *W. tinctoria* are distinct from those of *Indigofera arrecta* and *I. sumatrana*, although the Wrightia enzyme has some action on the glucoside of Indigofera, and *vice versâ*. The question of the conditions leading to the formation of indican in plants is discussed at some length. Indican is produced in the dark by etiolated shoots of *I. arrecta*, and there is no variation in indican content between night and day in *I. arrecta* and *I. sumatrana*. Moreover, no marked effect is produced by keeping plants of *I. sumatrana* in the dark for thirty-six hours. In the light of present knowledge no definite function can be assigned to the indigo-yielding glucosides in general or to the glucoside of any special species.

THE last quarterly Bulletin of the Seismological Society of America (vol. v., 1915, pp. 121–9) contains the presidential address delivered by Mr. A. McAdie on August 4. The writer notes that the last catalogue of earthquakes issued by the International Seismological Association was that for the year 1907, published five years later, and he suggests that the catalogues for subsequent years might be issued under American auspices, possibly with the aid of the Seismological Society. The material for such catalogues is now in German hands, and it is worthy of notice that Mr. Otto Klotz, of Ottawa, has been compelled to suspend his annual lists of epicentres owing to the lack of reports from Europe since the outbreak of the war. Moreover, urgent as are the claims of the war upon us, the Seismological Committee of the British Association has not ceased its useful task of collecting and analysing the records from British and Colonial observatories, and no other country in the world is connected with earthquake stations so numerous and so widely scattered over the globe.

THE Weather Bureau of the U.S. Department of Agriculture has reprinted a "Note on the Effects of Raingauge Exposures," by Mr. W. G. Reed, from the *Monthly Weather Review* for July, 1915. For two years the University of California has been engaged in an extensive study of the rainfall conditions over the watershed of Strawberry Creek, which has an area of about one square mile. During 1913–14 rainfall measurements were made from five standard 8-in. gauges, visited at the end of each storm, and in the autumn of 1914 the number of gauges was increased to thirteen. The gauges are at different heights above sea-level, ranging from 520 to 1655 ft., and the heights above ground range from 8 to 22 in. It is stated that from a strictly meteorological point of view the most important result so far seems to be the difficulty, if not the impossibility, of determining the precipitation on a watershed *by means of ordinary gauges* where the area is broken into valleys and ridges. It was hoped to make experiments with shielded gauges, but this was not carried out. It is noted that the catch of the gauge is largely controlled by local conditions, and perhaps the desire or attempt to shield the gauge from wind has too much attention. Precise details are given as to the exposure of the several gauges and the results, and ratios of the individual gauges to the average are given. The discussion has been carried out with great care and affords an exceedingly interesting inquiry.

THE "James Forrest" lecture before the Institution of Civil Engineers this year took the form of a detailed critical paper on electric railways, by Mr. H. M. Hobart, and in the absence of the author, in America, was read by Mr. John A. F. Aspinall. Mr. Hobart described in detail the working of the Butte, Anaconda, and Pacific 2400-volt direct-current railway, and other American lines, and gave exhaustive figures to show the gain in economy since the steam locomotives have been replaced by electric locomotives. Comparing the single-phase and high-pressure D.C. systems, he argued that even with sparse traffic the latter was the most economical. His general conclusions were that we are on the eve of the extensive employment of electric locomotives on railways at present run by steam, that the D.C. system is the most appropriate, and that D.C. locomotives for use from high-pressure contact conductors are now a thoroughly demonstrated success.

THE *British Journal of Photography* for December 24, 1915, contains the first part of Mr. F. J. Cheshire's lecture before the Royal Photographic Society on the modern range-finder. With the help of a diagram involving two similar triangles the geometry of range-finding is very clearly explained, and it is shown that the error in the measured range due to a constant small error in the determination of the displacement of one image with respect to the other is proportional to the square of the range. Mr. Cheshire starts with a simple range-finder consisting of two photographic cameras firmly attached to the ends of a rod a yard long, so that their lenses are in the same plane. He shows how by first pointing the instrument at a star and marking the positions of the images on the ground glass plates in the focal planes, then getting the image of a near object on the star mark in the left-hand camera, and measuring the distance of the image from the star mark in the right camera, the distance of the object from the cameras can be found. From this simple instrument it is shown how the range-finders of Clark (1858), Adie (1860), Mallock (1885), Christie (1886), Barr and Stroud (1888), and Marindin (1901) may be considered to have developed.

FOR many years past the custom of delivering lectures before the Chemical Society at its ordinary scientific meetings has practically lapsed, although an important series of memorial lectures has been maintained. Possibly as a result of the diminished flow of miscellaneous researches caused by the prolongation of the war, the custom has now been revived. The first lecture of the series, on "The Principles of Crop Production," was delivered by Dr. E. J. Russell, of Rothamsted, on November 18, 1915, and is reproduced in full in the Society's Journal for December, 1915. The lecture is illustrated with a striking series of diagrams, as well as by actual photographs showing the effect on the growth of the plant of various quantities of manures. Further lectures will be given by Prof. Bragg and by Mr. F. Gowland Hopkins.

A NEW form of viscometer is described by Mr. W. R. Bousfield, K.C., in the recent December issue of the

Chemical Society's Journal. The whole of the circulating system is enclosed, so that it can be immersed completely in a thermostat, the movement of the liquid being controlled by means of a series of taps connected to a suction-pump. The capillary is arranged in a vertical position, but contrary to the usual practice the flow is in an upward direction, so that the risk of partial obstruction of the capillary by particles of dust is greatly diminished. The adjustment of the volume of the flowing liquid is practically automatic and very exact. A special tube with a tap is provided, whereby the liquid to be tested can be drawn from the centre of a stock-bottle after ample time has been allowed for all traces of sediment to settle; this is a marked improvement on pouring the liquid into the viscometer directly or from an ordinary pipette. The new viscometer has been tested during several years of actual practice, and promises to take a permanent place alongside the pyknometer and the stills for conductivity-water, which have already been described by the author.

THE University of Chicago Press has in preparation for early publication in the "University of Chicago Science Series":—"The Origin of the Earth," by Prof. T. C. Chamberlin, and "The Isolation and Measurement of the Electron," by Prof. R. A. Millikan. The volumes will be issued in this country by the Cambridge University Press.

OUR ASTRONOMICAL COLUMN.

COMET 1915*e* (TAYLOR).—This comet has been under observation a number of times at the Hill Observatory since the beginning of the year. It has slowly increased in brightness. The ephemeris given below (No. 498, Eph. Zir., *Astronomische Nachrichten*) is based on the second orbit calculated by Messrs. Braae and Fischer-Petersen, and is for 12h. M.T. Greenwich:—

Jan.	R.A.	δ	Jan.	R.A.	δ
	h. m. s.	° ′		h. m. s.	° ′
12	5 2 47	+13 8·0	18	5 2 28	+16 13·9
14	2 30	14 9·1	20	2 44	17 17·2
16	2 24	15 11·1	21	3 13	18 20·9

The R.A.'s increase after January 16. The comet continues to approach the sun. An observation on January 7 showed that the ephemeris then required corrections of +2·7 min. in R.A. and −43″ in declination. It may be remarked that it is moving through a region devoid of bright stars—N. and W. of Bellatrix.

We have received the following upon this comet from the Union Observatory, Johannesburg, December 9, 1915:—

On December 2, 1915, Mr. Clement J. Taylor, of Herschel View, near Capetown, reported to the Union Observatory, Johannesburg, he had found a comet in Orion on November 24, and that it was near 31 Orion, and moving northwards. It was observed on the same evening and subsequently. The 1915·0 astrographic positions obtained at the Union Observatory are:—

Greenwich Time.

1915		h. m. s.		° ′ ″
Dec. 2·347	...	5 24 45·9	...	0 39 6
4·325	—	5 23 50·3	...	0 21 48
5·347	...	5 23 19·9	...	0 12 12

COMET 1915*a* (MELLISH).—Some measurements of the additional nuclei of Mellish's comet (1915*a*) have been made by Mr. Knox Shaw (Helwân Observatory Bulletin, No. 16). The nuclei were situated on a bright ray in the tail, the one more distant from the head being the brighter, and in the later stages appeared to be subdividing. During May these extra nuclei receded from the head with daily motions of about 1000 km.

THE SPECTRUM OF THE BINARY SYSTEM 41 ERIDANI.—In Bulletin No. 274, Lick Observatory, Dr. G. F. Paddock investigates the question of spectroscopic orbit formulæ, especially considering the derivation of elements of nearly circular orbits, and the reduction in cases where spectra of both components are available. In the first case, he improves the determination of position and epoch of periastron, and in the second enables the reduction of the double measures to be carried on as one operation instead of using them to obtain two symmetrical solutions. The new formulæ have been put in use in a study of the spectroscopic binary 41 Eridani (mag. 3·9, Sp. B9A). Briefest reference only can be made to some of the many important questions dealt with. A definite value is adopted for the wave-length of the magnesium line—4481·400 A., or 4481·230 I.A., and the variations of wave-length of this line alone are employed in deducing the orbit. All the thirty-nine spectrograms employed show it as a double line due to the two component spectra. The system proves to be one of normal values, although accurate photometric measures are yet required to fix the inclination of the orbit-plane. Measured wave-lengths are given for fifty lines (K to Hβ) and origins discussed. The lines are stated to be not so sharp as in Sirius, and distinctly fainter. A noteworthy feature is the number of proto-Mn lines represented. Intensities are merely verbally described. Two notes on the table of wave-lengths call for special remark. First, Mr. F. E. Baxandall, in 1914, published several new enhanced lines of Mn, including one at λ 4282·65. This origin will account for the line at λ 4282·7. Secondly, the line λ 4416·9, although masked in spark spectra, was shown by Prof. A. Fowler to be an enhanced line of iron, and provided a recognised origin for the stellar line. These points only emphasise the conclusion that 41 Eridani has an essentially enhanced line spectrum.

THE CONSTANTS OF THE TERRESTRIAL SPHEROID.—The Paris Conference (1911) adopted Hayford's values for the equatorial radius and aplatissement. Since then Helmert has derived a new value for the radius, and S. Wellisch suggests that Hayford's and Helmert's results should be combined. Instead of taking the adopted Hayford values he proposes that the mean be taken of three sets of values based on different assumed depths of the isostatic compensation layer 162·2 km., 120·9 km., and 113·7 km.). Taking Helmert's values with weight = unity, and the modified Hayford values with weight = 4, he obtains for the equatorial radius = 6,378,372 metres, excess over polar radius = 21,476 metres, whence the reciprocal of the aplatissement = 297. The length of the "metre" derived from these values is 1·00022632 metres (*Astronomische Nachrichten*, 4822).

SCIENCE AT EDUCATIONAL CONFERENCES.

"WHAT difference has the war made? I believe it has opened the eyes of the nation to the perils which arise from the neglect of intellectual things, the satisfaction with book knowledge, the inattention to facts, the concentration on physical prowess, and on a passive kind of material prosperity—the widespread ignorance of natural facts even among our leaders, and consequent contempt for investigation and expert knowledge. What has become apparent is the ignorance of our governing classes. The ignorance of all classes. The facts that education has not

led to widely diffused knowledge, was not designed to lead there, that it failed to stimulate any healthy intellectual interest in the majority, have now glared at us too prominently to be overlooked."

The above is an extract from the inaugural address which Sir Oliver Lodge delivered at the opening of the fourth annual Conference of Educational Associations. The audience was large—it was drawn from thirty educational societies—and the address was the precursor of strenuous activity displayed during the week by the great majority of the societies. It is not without significance that the representative committee which organised the conference should have sought a leader from the ranks of scientific workers, in an hour so fateful to the education of the nation. For this year there has been no question as to the desirability of holding educational conferences; the lessons of the war having intensified among teachers of all grades their sense of the national responsibilities of their work. Whether the same recognition of the inevitable consequences of training (or lack of training) in school has been reached by the public, is doubtful. There is only too good ground for Sir Oliver Lodge's warning to parents:—"Conservatism is natural in education. We have been through a certain mill, and we think it proper that our children should go through the same process. If a great school were subjected to sweeping reforms, a whole generation of fathers and grandfathers would feel themselves defrauded of the right of basking again in the queer, half-forgotten traditions of their boyhood." Our readers may recollect that the headmaster of one of our greatest public schools has declared that any extension of science in the school was impeded by the indifference, or even opposition, of the parents.

The address passed from castigation of anti-scientific obscurantism to constructive suggestions for training the average fourth form boy, involving a cultivation of inventive faculty by a variety of enterprises sometimes requiring mechanism, facilities for genuine experimentation and subjective discoveries, for self-developed interests and actual experience of the workings of nature. The utmost importance should attach to elementary physiology, and hygienic details ought to be inculcated as part of the tradition of the race. These and other points were treated in the address in a manner absolutely in accord with the practice of our more progressive schools for many years past. But although to some present their restatement may have seemed superfluous, in reality Sir Oliver Lodge was doing a most useful service by backing the methods of our science teachers with the support of his acknowledged authority in the realm of science. How necessary such support is may be gauged by the fact that within three days the Board of Education actually circulated a suggestion to secondary-school authorities that economies should be effected by dropping laboratory work in schools and substituting lecture-demonstrations!

Prof. A. N. Whitehead treated the Mathematical Association to a brilliantly phrased address, and his concluding sentences may serve as a comment on the endeavour of the Board of Education to reduce the efficiency of science teaching:—"The race which does not value trained intelligence is doomed. To-day we maintain ourselves. To-morrow science will have moved forward yet one more step, and there will then be no appeal from the judgment which will be pronounced on the uneducated." Prof. Whitehead fell foul of external examinations, and put a broad view of the task of mathematical teachers, defining mathematics as the science of life. The impression conveyed to at least one of his hearers was that this concept of mathematics should inspire both teacher and taught, the proper attitude being induced in the learner by giving him problems which deal with things which really matter in the big world.

The pervading sense of national responsibility was perhaps most intense at the meeting of the Public Schools Science Masters, who met, as did also the Mathematical Association, at the London Day Training College. The president, Sir William Osler, gave "The Fateful Years, Fifteen to Seventeen," as the title of his address, the main feature of which was a plea that the schools should give intending medical students such a training in physics, chemistry, and biology that they may enter at once upon their purely medical studies as soon as they enter the university. The address, which had much literary charm as well as common-sense merit, was well received, the general feeling of the members being clearly in accord with their president. It was pointed out, however, that the real obstacle to the plan suggested was the faulty regulations of the University in which Sir William Osler is Regius professor. The schools tend to send their best boys to Cambridge and London, because Oxford will not allow the medical course to begin at once. From the discussion it appears that the would-be medical student enters in October, is compelled to wait until December before he is allowed to pass "Divinners," and has then to wait until the next medical course opens in the following October. The irony of the situation is heightened by the fact that the university has just sent an appeal to the head-masters on the lines of Sir W. Osler's request to the science masters. The situation would be humorous at another time; but at the present moment it is of the most obvious importance that every encouragement should be given to aspirants to a medical degree, and that every hindrance to rapid and thorough qualification should be removed. The discussion will, it may be expected, cause the rescission of the offending regulation.

Like most of the work of the meeting, the next paper dealt with a topic of immediate national concern, viz., the improvement of agriculture. With a force derived from unrivalled knowledge, Mr. Christopher Turnor dealt with the desirability of giving a bias towards agriculture in the science teaching, pointing out the need for arousing interest in the minds of those landowners of the future who are at present in the public schools. He effectively contrasted the interest and energy shown by the leaders of Denmark with the state of affairs in England. England is the only country in which the agricultural population has *absolutely* declined. The present writer was reminded of a remark made to him four years ago by a Swedish professor:—"You have a wonderful country. England will be a garden, *when you have developed your agriculture*." A whole morning was given to a discussion on war work in schools, which was so practical and informative that its publication appears to be contrary to the interests of the various institutions concerned. Instructors from Woolwich and the War Office each testified to the value of the help which science masters are giving, especially by giving future officers instruction which will be immediately useful in active service. The members of the association, and especially Mr. C. L. Bryant, who, as honorary secretary, is the intermediary between the War Office and the science masters, may be congratulated on the work they are doing in this connection.

There was a discussion on school museums, as to which it is hoped to say more in a future article. The same remark applies to various discussions at different societies, also to the exhibitions; the present article being restricted to those problems of science instruction which directly influence national affairs. It is satisfactory to record that a sub-committee, consisting of Messrs. Hill, Tripp, and Oldham, has been

appointed to report upon possible ways and means of furthering the claims of school science, and of raising it from its present position, in view of the fact that the status of science in the public schools has so important a relation to the recognition of science by the nation's leaders.

The Association of Teachers in Technical Institutions arranged a discussion on "Technical Education: the War and After," which formed part of the great conference at the University of London. The attendance was relatively small; a fact quite creditable to the Association, as the absentees were all engaged on technical work of value and urgency in connection with the war. Nevertheless the quality of the papers and speeches evoked justified the organisers of the meeting—they will be read both in England and abroad in the general report of the Conference. Mr. Barker North (Bradford Technical College) reviewed the situation, laying emphasis on the necessity for maintaining the efficiency of technical institutions if we wish to succeed in the coming industrial war. He advocated more central organisation, not only in instruction and research, but also in commerce and industry. Referring to the Board of Education, he reiterated Mr. Abbott's warning that any diminution in expenditure which interferes with the efficiency of technical education will handicap the nation in the coming industrial struggle.

Mr. James Baker vividly sketched the contrast between England, with miserably limited technical departments and slum-infected cities, and Bohemia, with splendid scientific institutions, rapidly advancing industries, and consequent abolition of poverty. Incidentally he referred to the high state of general culture and enlightenment in Bohemia, where the people wish to be on England's side in the war.

Dr. C. Dorée considered the possibilities of industrial research work in technical institutions. The remarkable applications of science in the war have opened the eyes of manufacturers, and many firms for the first time have employed a chemist. What is more, they have admitted that scientific methods pay better, and that Government specifications are passed more easily with a chemist than without one. Those firms are not likely to do without such trained assistance in the future. Seeing that instruction must form a large part of the work of technical institutions, it is recommended that a director of research should find out problems, obtain material, and apportion the work among the institutes according to their capacity. Such centrally directed work is now being carried out in making drugs, and is quite successful.

The Science Teachers' Association also held a successful meeting, the description of which must be deferred. Efforts to broaden the membership and widen the work of this society are being considered. The Council of the Association will do well to throw its energies at once into the work of expansion.

The striking vigour and success of the whole Conference of Associations demonstrate that teachers are alive to the national position. Their united efforts are needed to make clear to the public, and to persons in high authority, that upon education, and especially on scientific education, depends our progress towards a wiser England.

G. F. DANIELL.

PRIZE AWARDS OF THE PARIS ACADEMY OF SCIENCES, 1915.

Mathematics.—The Francœur prize is awarded to Joseph Marty for his work on the theory of integral equations. The Bordin prize is postponed to 1916.

Mechanics.—No award was made of the Montyon prize; the Poncelet prize is accorded to Charles Rabut, for his work as a whole; Umberto Puppini receives the Boileau prize, for his work in hydraulics.

Astronomy.—The Lalande prize to Lucien d'Azambuja, for his important contribution to the daily measurement of the upper layer of the solar atmosphere and to the recognition of the action exercised by the magnetic field on band spectra; the Valz prize to Armand Lambert, for his work as an observer and in applied mathematics; the G. de Pontécoulant prize to Louis Fabry, for his researches on the asteroids; no award of the Pierre Guzman prize is made.

Geography.—The Tchihatchef prize to J. Couyat-Barthoux, for his geological and geographical work on the Sinai and Suez Canal regions; the Gay prize to Henri Lecomte, for his studies on the distribution of plants in Indo-China.

Navigation.—The Extraordinary prize of 6000 francs is divided between Maurice Marchand (3000 francs), for his memoir on the protection of the submarine against mines, Jean Lorfèvre (1500 francs), for his essay on the use of Diesel motors, and Louis Jauch and Auguste Masméjean (1500 francs jointly), for their work on marine engines; the Plumey prize is not awarded.

Physics.—The Hebert prize to Michael Idvorsky Pupin, for the whole of his work in applied electricity; the Hughes prize to R. Marcelin, for his theoretical and experimental memoir entitled "Contribution to the Study of Physico-Chemical Kinetics"; the H. de Parville prize to Jean Blein, for his contributions to the thermodynamics of gases and detectors in wireless telegraphy; the Gaston Planté prize to Marcel Moulin, for his researches on the positive rays of radium, ionisation, radiation of black bodies, and other interesting questions of modern physics; the Pierson-Perrin prize to Maurice de Broglie, for his studies on ionised gases, the Brownian movement, and the diffraction of the X-rays.

Chemistry.—The Jecker prize to Gabriel Bertrand, for his work in organic and biological chemistry; the Cahours prize to Paul Viguier, for his researches on tetrolic aldehyde and some of its derivatives; the Montyon prize (unhealthy trades) to André Kling (2500 francs), for his work in the Paris Municipal Laboratory; honourable mentions (1500 francs), to Daniel Florentin and René Schmutz (1000 francs); the Houzeau prize to Paul Pascal, for the whole of his work in inorganic and organic chemistry.

Mineralogy and Geology.—The Delesse prize to Albert de Romeu, for his petrographic researches, and an encouragement (1000 francs) to A. Laville, for his researches on fossil vertebrates; the Joseph Labbé prize to René Tronquoy, for his studies on tin ore deposits; the Victor Raulin prize to Louis Doncieux, for his palæontological researches; no award of the Cuvier prize is made, and the funds will be used for charitable purposes.

Botany.—The Desmazières prize to Giovanni Battista de Toni and Achille Forti, for their contributions to the Mediterranean algological flora; the Montagne prize to Fernand Camus; the de Coincy prize to Pierre Choux, for the whole of his botanical work; the Thore prize to Isidore Doin; the de Rufz de Lavison prize to Paul Becquerel, for his researches on the life of seeds.

Anatomy and Zoology.—The Savigny prize to Pierre Fauvel, for his researches on annelids obtained in the voyages of the *Hirondelle* and the *Princess Alice*; the da Gama Machado prize is not awarded.

Medicine and Surgery.—Montyon prizes: A prize of 2500 francs to François Maignon, for his researches on the toxicity of albumenoid materials; an honourable mention of 1500 francs to Emile Terroine, for his work on pancreatic secretion; citations to Eugène Olivier and Dr. Ginestoux; the Barbier prize to Charles Dassonville and Cléry Rivière, for their memoir on epizootic abortion in mares; very honourable mentions to Charles Besnoit and V. Robin, for their works on cutaneous sarcosporidiosis of the ox,

and to Henri Bocquillon, for his botanical and therapeutical studies of tropical plants; 2500 francs from the interest on the Breant prize to M. Brumpt, for his work on parasitology; the Godard prize to Noël Hallé, for his researches on chronic renal tuberculosis; a mention to Henri Vignes, for his notes and researches on menstruation; the Baron Larrey prize is not awarded; the Bellion prize to Henri Gougerot, for his memoir on the treatment of syphilis in practice; a very honourable mention to Emile and Camille Guillot, for their work entitled "The Healthy House"; the Mège and Argut prizes are not awarded; the Chaussier prize is not awarded, but an encouragement (500 francs) is given to Raoul Benon, for his book on post-traumatic psychic and nervous troubles; the Dusgate prize is not awarded, but Arcangelo Creazzo receives a mention for his work on real and apparent death.

Physiology.—The Montyon prize to André Thomas, for his work on the brain; the Philipeaux prize to Henri Stassano, for the whole of his work in physiology; the Lallemand prize between Jules Glover (1000 francs), for his work on the physiology of the voice applied to art and industry, and Pierre Achalme (800 francs), for his book on electrotonics and biology; no memoirs have been received dealing with the subject proposed for the Pourat prize, and the prize is postponed to 1917; the Fanny Emden prize to Jean Chatanay.

Statistics.—The Montyon prize (1000 francs) to Fernand de Montessus de Ballore, for his seismological work.

History of Sciences.—The Binoux prize between Albert Anthiaume, for his work on the history of nautical science, F. Marguet, and George Sarton.

General Prizes.—Berthelot medals to Gabriel Bertrand, M. Viguier, and Paul Pascal; the Becquerel prize between M. Arnaud (2000 francs), Jean Merlin (750 francs), and M. Rabioulle (750 francs); the Gegner prize (3800 francs) to G. Cesaro, for his work in descriptive crystallography; the Lannelongue fund, the interest is divided between Mme. Cusco and Mme. Rück; the Gustave Roux prize to Lucien Berland, the prize reserved from 1914 to Georges Lery; the Trémont prize to Charles Frémont; the Wilde prize to Commandant Batailler, for his work in experimental mechanics relating to ballistics; the Lonchampt prize to Fernand Jadin and Albert Astruc, for their work on the presence and estimation of arsenic and manganese in the vegetable kingdom; the Saintour prize to A. Blondel, for his work on the theory of tides; the Henri de Parville prize between Jean Escard (1000 francs), for his books dealing with scientific and technical questions, Gustave Loisel (1000 francs), and Albert Buisson (500 francs); no memoir dealing with the subject proposed for the Vaillant prize was received, and the prize is postponed to 1919; the Grand prize of the Physical Sciences to Henry Hubert, for his study of the geology of French Western Africa; the Le Conte prize to Sir Almroth Wright, for his researches in antityphoid vaccination; the Petit d'Ormoy and Laplace and Rivot prizes are not awarded.

WIRELESS COMMUNICATION.

SOME notes on the present state of wireless telegraphy were communicated by Dr. M. I. Pupin in the course of a lecture which he delivered before the National Academy of Science in New York, on "Aerial Transmission Problems." None of the points raised by Dr. Pupin were entirely new, as they have been frequently discussed in both continents without being appreciably helped towards solution. But the manner in which they were presented and illustrated assisted towards a better understanding of the formidable character of the obstacles in the way of extending the distance of wireless communication. These obstacles are due mainly to the interference produced by electrical waves, which are passing through the terrestrial atmosphere continuously, and it is not until we attempt to magnify the minute signals coming from a distant transmitting station that we are really aware of their presence. An engineer who took part in the recent long-distance wireless telephony trials and listened for the famous telephone message from Arlington, reports that at times "it was drowned completely in a roar of musketry," due, of course, to the action of the electrical waves produced by the incessant electrical discharges in the atmosphere. All attempts up to the present which the "practical" wireless engineer has made in the direction of overcoming these disturbances have consisted in increasing the power applied at the transmitting station so as to make the incoming signals at the receiving station stronger than the signals made by the "static." Ordinary electrical tuning is not sufficient for the purpose, because every system which is highly selective through ordinary tuning is also highly sonorous; every tap of the static will cause it to vibrate, and it will vibrate in the same way as when it is under the action of the signalling waves. The method advocated by Dr. Pupin involves the use of a sectional wave conductor between the antenna and the receiving apparatus, which will not transmit electrical waves of a frequency higher than a given range of frequencies. By this means, he states, "the station becomes an ear, which is quite sensitive for frequencies which are in the vicinity of the signalling frequency, which is deaf to frequencies which are considerably beyond this range, as most static disturbances are." "Similarly," he adds, "a sectional wave conductor can be constructed which is quite responsive to frequencies in the vicinity of the signalling frequency, but absorb almost completely everything below this range."

Dr. Pupin corrects the popular misconception that wireless telegraphy formed its first roots in German soil, whereas in reality it is a particular case of the oscillatory motion of electricity discovered by Joseph Henry, and the laws of which were formulated by Kelvin. It is true that Hertz employed these oscillations more skilfully than anybody else did prior to his time, and thereby succeeded in improving experimentally the complete validity of the physical foundation of the electromagnetic theory which was conceived and formulated by Clerk Maxwell, and paved the way for Mr. Marconi. Dr. Pupin claims that "Marconi discovered wireless telegraphy," but he altogether ignores the achievements of Branly, of Lodge, of Popoff, and others. It cannot be said of Mr. Marconi that he discovered the principles or invented the primary appliances upon which the transmission of electromagnetic waves are based. He accomplished his result by combining, in the utilisation of known principles, features which had been disclosed by others, which he improved and co-ordinated, with additional features of his own invention.

Mr. E. H. Colpitts, the research engineer of the Western Electric Company of America, under whose direction the apparatus was developed and the experiments conducted which resulted a few weeks ago in the wireless transmission of speech between Arlington, U.S.A., and Honolulu, on one hand, and Arlington and Paris on the other, discusses in the *Scientific American* the significance of the recent achievement in long-distance wireless telephony. The technical details of the system have already been described, so far as they are available, and chief interest in Mr. Colpitts's article lies in his views regarding the future of wireless telephony. He does not consider that it will displace line telephony, and even if it is physically possible and can be usefully employed, it must fail to be commercially practicable. Atmospheric disturbances were found to be a great drawback, while another difficulty

revealed in the Arlington trials was the susceptibility of the receiving stations to induction from near-by power circuits or electrical apparatus. With the present limited use of wireless, this latter trouble can be avoided by carefully choosing the sites of receiving stations, but it would become a serious factor if the use of wireless telephony became general. Mr. Colpitts predicts the use of wireless telephony for long-distance communications. Thus a transoceanic telephone cable is not an engineering or commercial possibility; and to enable, say, America to talk to Europe or Asia, wireless telephony will be the means chosen. In extending the possibilities of wireless communication between ships at sea there is a field for telephony, while from ship to shore wireless telephony is the only possibility.

THE TRANSMISSION OF BILHARZIA DISEASE BY SNAILS.[1]

THE cause of Bilharzia disease of man was discovered by Bilharz in 1851, and it is only now, more than half a century later, that the mode of transmission has been discovered. The disease is due to the presence of flukes in the mesenteric and vesical veins, or, rather, it is in the main the eggs which these worms lay that cause the inflammation which has such dire consequences. The cause being known, helminthologists of repute then naturally sought to determine how infection arose. It was known that the eggs hatched in water into ciliated embryos, and from what was also known of the life-history of other flukes, it was natural to conclude that in this case also the embryos next entered into the tissues of some fresh-water mollusc. This could be shown in two ways, either (1) by experimentally infecting molluscs with the larval forms (ciliated embryos), or (2) by dissecting molluscs from an endemic area and finding the larval forms in them. All attempts in these directions proved in vain. But it is astounding to learn in this report that whereas some fifty species of fresh-water molluscs occur in Egypt, only nine species are recorded as having been examined by the various observers who took up the problem. Nine species out of fifty! One cannot help adding that these observers really deserved their bad luck not to have by accident stumbled on the right mollusc.

Before, however, we proceed to describe how Dr. R. T. Leiper, who conducted this expedition, found the intermediate host (mollusc) we should point out at what stage our knowledge had previously arrived.

In Japan there exists in man and dogs a "Bilharzia" disease due to a different species of fluke, but to one belonging to the same genus. Japanese workers had shown that dogs could be infected by standing them in the water of flooded fields of infected areas, but not in water containing simply ciliated embryos, and they noted that the invading form differed so much from the ciliated embryos that an intermediate host seemed probable. Further, in 1913 it was announced that a reproductive stage of this fluke had been found in Lymnæus sp. Mice were also infected from the water in which snails had lived, these having been previously infected with larval stages. These results were fully confirmed and extended by Leiper and Atkinson in Japan. The problem of the Egyptian bilharziasis was now ripe for solution, and we see in the present report how rapidly Leiper and his colleagues effected it. On p. 23 it is stated the mission found bilharzia worms in three species out of eight of the commonest fresh-water molluscs within half an hour's train journey from Cairo!

[1] Report on the Results of the Bilharzia Mission in Egypt, 1915. By Temporary Lieutenant-Colonel R. T. Leiper. Journal of the Royal Army Medical Corps, July and August, 1915. (London: John Bale, Sons, and Danielsson.)

Other workers aware of the Japanese results were also attacking the problem. In July, 1915, Causton and Warren published the results of their experiments. Though they hesitated in forming a definite conclusion, it now appears certain that the cercariæ they found in *Physopsis africana* were those of bilharzia.

To return to the present report. At El Marg, a village where the only water supply is a branch of the fresh-water canal from Cairo to Ismailia and Port Said, forty-nine out of fifty-four boys of about twelve years of age were found to be infected. Fifteen species of molluscs were found in the canal when the water in the latter was turned off, which occurs for a fortnight every three weeks. The commonest species were *Planorbis boissyi, bullinus*, and *cleopatra* spp. The two former species "attracted" ciliated embryos of bilharzia eggs when these were presented to them in water.

P. boissyi was so commonly infected with bilharzia cercariæ (larval forms) that large quantities of cercariæ could easily be collected. Rats were successfully infected with these cercariæ, and the adult worms were found in the portal veins. An examination of the eggs proved them to be the human species. Experiments on monkeys now showed that the oral as well as the cutaneous modes of infection occurred, but the oral probably means mucosal and not gastric. The incubation period was one-two months in these animals, as it is in man. The main fact has now been discovered. There will remain the working out of details. Further work will be necessary on the life-history of the snails, and it will perhaps be wise to wait until we know this thoroughly before precise measures of prophylaxis are advocated, but we may point out some of the factors bearing on the problem.

The disease is commoner in the Delta and in the Fayum than in those parts of Egypt supplied with "basin" irrigation. For instance, as Madden has pointed out, Ghizeh furnishes to Cairo hospitals only about ten cases per 100,000 population, while Sharkieh furnishes twenty, Qaloubieh eighteen, and Menoufieh about thirteen. These latter provinces have perpetual irrigation, while Ghizeh has basin irrigation. The probable explanation is that perpetual irrigation favours the development of snails.

There are 30,000 children born annually in Cairo; 10,000 of these, it is said, become infected. How? Cairo has two water supplies, a filtered, and an unfiltered derived from the Nile. Now water that has been taken from the Nile and used for agriculture as a rule does not re-enter the Nile, but is removed by drains which eventually reach the sea, but south of Cairo a number of these drains re-enter the Nile, so that this is a possible source of infection of Cairo by its *unfiltered* water. Cercariæ, however, can only be kept alive experimentally for thirty-six hours in water, and it is calculated that if the water has entered more than thirty miles upstream the cercariæ should be dead before they reach Cairo. As regards the infection in Cairo, one would like to have the actual proof of the finding of cercariæ in the unfiltered water from the pipes. The opinion is expressed that storage for 1½–2 days of this unfiltered water would protect Cairo. In villages, the principle involved is a simple one, viz., turning off or diverting the water from a particular canal, with the result of killing the molluscs, but the problem is complicated by a consideration of the agricultural aspect of such a procedure.

It is at present premature to indicate exactly how this can be best done; a very careful study of the life-history of snails will, as we have said, be necessary, but we have no doubt that Egypt can at last be freed from the scourge of bilharzia, evidence of the ravages of which has been found even in the mummies.

J. W. W. S.

MODERN SYSTEMS OF INDEPENDENT LIGHTING AND HEATING.[1]

II.—*Acetylene Lighting.*

ACETYLENE is now quite a familiar method of lighting country houses, and many early difficulties against which the system had to contend have been removed. Originally the gas could not be obtained in a state of purity. The impurities were apt to give rise to a slight "haze" or mist in the room, the odour of the gas was disagreeably evident, and in the early forms of generating plant sufficient care was not always taken to avoid mixtures of gas and air capable of giving rise to explosions.

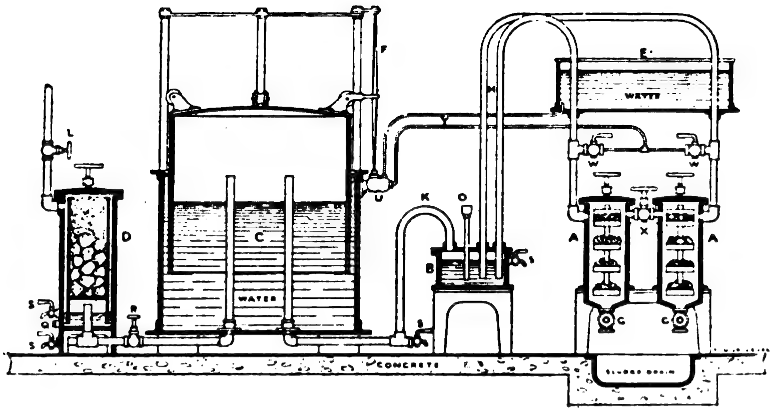

FIG. 1.—Sectional view of "Imperial" acetylene generator.

The careful purification of the gas, and the improved designs of the generators of to-day, have removed these defects. It is, however, now as ever, important for the householder who instals acetylene to purchase a good standard type of plant and to secure the very best workmanship throughout the installation. Acetylene, like petrol-air gas, is used to a great extent in remote situations, where expert assistance is not readily available. A cheap and inferior installation may therefore be a constant source of trouble and annoyance. Many reputable firms will undertake to execute any repairs within a given period after installation, thus making themselves responsible for the plant being in good order.

The acetylene plant is usually stored in a small outhouse, and the gas is led into the house through pipes in the same way as coal-gas; the piping, however, is usually very much smaller. It is impossible to describe acetylene generators in great detail within the space of this article, but it may be said they are divided broadly into "carbide to water" and "water to carbide," and into automatic and non-automatic types. Generally speaking, the addition of water to carbide is considered preferable, the water being so easily controlled. Automatic plants are now preferred for sustained lighting on a large scale.

The essential parts of an acetylene generator are as follows:—

(1) The generator proper, which contains the carbide. This is divided into compartments in such a way that the charge in one compartment is used up before the water enters the next. In modern installations duplicate generators are frequently used. By merely turning a tap either can be put into action, and in an emergency it is possible to continue supplying gas from one generator while the other is being attended to and recharged.

(2) The washer, which consists essentially of a piece of apparatus through which the gas passes on its way to the gas-holder, and is partly purified in doing so.

(3) The water-supply tank, which may be automatically controlled by the aid of a piston, actuated by a projection in the gas-holder, which in its descent admits more water as the gas becomes exhausted.

(4) The gas-holder, in which the gas is collected when it has passed through the "washer."

(5) The drier and purifier, by which the gas is finally purified on its way into the house for actual use.

In Figs. 1 and 2 these various parts are seen in a typical "Imperial" plant.

It is interesting to notice that while the nozzles of burners used for petrol-air gas require to be larger than those used with ordinary coal-gas, acetylene burners, on the other hand, must have a very small aperture. This is one reason why good methods of purification are necessary, as in the early days impurities sometimes led to the small apertures in the burner becoming choked with soot. Modern acetylene burners should last a long time. The smaller types merely employ a pin-hole, the large types (*e.g.* the "Roni") have a slot. A common arrangement is to have two twin burners, the flames of which impinge on one another. The ordinary range of consumption of acetylene burners is from ½ to 1 cub. ft. of gas per hour, the usual pressure being about 4 in. of water. The efficiency is generally stated, but is usually taken as about 25–30 candles per cub. ft. of gas. One may expect to get, roughly, 5 cub. ft. of gas from 1 lb. of carbide.

Bunsen burners and incandescent mantles have been used with acetylene, but the general impression is

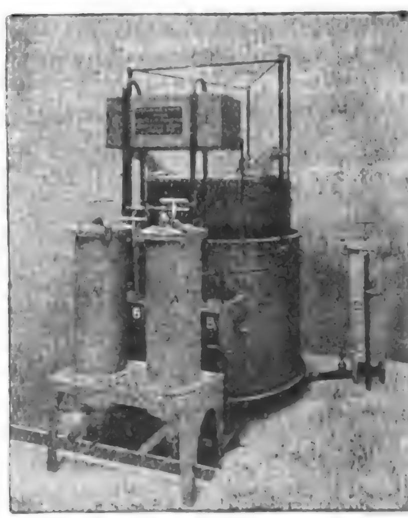

FIG. 2.—"Imperial" acetylene generator (general view).

A, Generator
B, Washer.
C, Holder.
D, Purifier

When the plant is in action water flows from the tank E into the generator A through the valve U. The acetylene thus produced passes through the washer B into the bell at C, causing it to rise. When the holder is about half full the control tap is automatically turned off and no more gas is generated. As the gas is used up the bell falls and turns the tap on again so that gas is generated once more. This automatic action continues until the carbide is exhausted. Meanwhile the gas generated passes out through the purifier D into the pipes. By closing one of the taps W either of the two twin generators can be put out of action. The sludge is run out through the cock G, and the drain pipes S S S serve to run off any accumulated water.

[1] Continued from p. 524.

that the gain in efficiency is offset by the comparatively short life of the mantles.

Acetylene installations have been widely used for country houses, for country railway stations, etc.; in fact, in similar circumstances to petrol-air gas. The comparative advantages of the two systems have been the subject of much discussion. The fact that there are opportunities for both seems to be borne out by the practice of several firms who are prepared to instal either system.

The following might be taken as a very rough indication of the cost of installations:—

Size of installation	Cost of plant £	Total cost of installation £
30 lights ...	30–40 ...	75–120
50 ,, ...	50–60 ...	130–160
100 ,, ...	75–90 ...	180–250

FIG. 3.—Portable acetylene lamp of very simple construction: requires 1 lb. of carbide and is stated to give 50 candle-power for eight hours.

Here, again, allowance must be made for the very variable item of fixtures, on which a large sum may be expended if artistic effects are in demand. Prices will also be found to have risen somewhat during the war.

A special province for acetylene lighting is in connection with portable lamps, some of which are of very ingenious and attractive design. Lamps of this kind are in demand for temporary workshops and construction work undertaken during the night time, a type of apparatus much used for the latter purpose being the acetylene flare and generator, which is equipped with a parabolic reflector designed to concentrate the light over a small area. (Shortly before the war a large number of these flares were introduced into the Pantheon, Paris, on the occasion of the bicentenary of Jean Jacques Rousseau. It was only just before the performance that the organisers suddenly realised that there is neither gas nor electricity in the building.)

In Fig. 3 is shown a very handy form of portable lamp recently introduced by the Thorn and Hoddle Acetylene Co. Its characteristic is extreme simplicity. All that is necessary is to throw a charge of carbide into the inner vessel, pour some water into the outer can, and light up. There is no cock attached to the lamp, and this enables the gas consumption to be automatically balanced by the inlet of water through a special valve. The lamp is very strong, and can be carried in the hand, stood up beside the work, or hung from the roof or wall. It is said to be now very widely used for military purposes.

Acetylene, like petrol-air gas, can be used for heating and cooking with small stoves consuming from 1 to 6 cub. ft. per hour, but is not recommended for use on a large scale. It would, however, be useful for laboratory work. Another application of acetylene which sometimes comes in handy in this connection is its use, in connection with oxygen, for welding purposes. For this purpose tubes of dissolved acetylene are sometimes used. The gas is dissolved under pressure in acetone, and is evolved when the pressure is relaxed. Such cylinders can be very readily detached and sent off to be refilled, a newly-charged vessel being substituted.

THE BRITISH MYCOLOGICAL SOCIETY.

THE Transactions of the British Mycological Society for 1914 (vol. v., part 1; May, 1915; Worcester: E. Baylis and Son) contain a number of interesting articles. Prof. A. H. R. Buller's presidential address on the fungus lore of the Greeks and Romans shows the various ways in which fungi attracted the attention of the ancients. Those who are adverse to the idea of our various edible kinds of fungi being considered a valuable source of food will note that Dioscorides was so suspicious of all edible fungi (although these were consumed in large quantities by the Greeks and Romans) that he recommended the taking of an emetic after the eating of any kind. Pliny, in referring to the rust of cereals, which he calls "the greatest pest of the crops," says that it may be averted "by fixing branches of laurel in the fields." Such kinds of belief die hard; the present writer can recall that when, a few years back, the American gooseberry-mildew first invaded Kent, a prominent fruit-farmer announced his intention of planting a hedge of Eucalyptus to ward off this new pest.

Miss Gulielma Lister, well known as the monographer of the Mycetozoa, publishes an account of the Japanese species collected during the past eight years by Mr. Kamagusu Minakata. The species new to science are illustrated with the beautiful and faithful drawings characteristic of Miss Lister's work. Mr. Minakata, moved primarily by a sense of their national importance, has protested against the demolition of the ancient Shintoist temples. The sacred groves of ancient trees round these temples have proved an excellent "hunting-ground" for Mycetozoa. So vehement on one occasion was his opposition that it led to his being put into prison for eighteen days; this was not wholly wasted time, however, since he was able to collect a species of Stemonitis "on an old post in the gaol."

Mr. J. Ramsbottom contributes a very useful summary of recent work on the cytology of fungus reproduction, and in a separate note points out that the "*guttulae*" in spores of the Discomycetes—a feature commonly introduced into the diagnosis of species—disappear in sections mounted in glycerine. Biographical accounts of the late Dr. M. C. Cooke and of the Rev. W. L. W. Eyre are also given by the same author.

Mr. C. K. Sutherland describes some new genera of marine Pyrenomycetes.

One of the activities of the society is the holding annually of "fungus forays" in the spring and autumn; those held in 1914 led, as in previous years, to the discovery of fungi new to Britain. It is satisfactory to find that care is taken to obtain a critical determination of all the species collected. The collection of *Fusicladium dendriticum*—the cause of the destructive disease known as apple "scab"—on *Pyrus torminalis* suggests that some of the fungous "pests" of the fruit-grower may—like some of the insect pests—emerge from woods which often neighbour fruit-farms.

INTENSIVE WORK IN SCHOOL SCIENCE.[1]

IN a presidential address, and to this audience, a preliminary reminiscent note may be pardoned. As a boy I had the common experience of fifty years ago—teachers whose sole object was to spoon-feed classes, not with the classics, but with syntax and prosody, forcing our empty wits, as Milton says, to compose "Theams Verses and Orations," wrung from poor striplings like blood from the nose, with the result that we loathed Xenophon and his ten thousand, Homer was an abomination, while Livy and Cicero were names and tasks. Ten years with really able Trinity College, Dublin, and Oxford teachers left me with no more real knowledge of Greek and Latin than of Chinese, and without the free use of the languages as keys to great literature. Imagine the delight of a boy of an inquisitive nature to meet a man[2] who cared nothing about words, but who knew about things—who knew the stars in their courses, and could tell us their names, whose delight was in the woods in springtime, who told us about the frog-spawn and the caddice worms, and who read to us in the evenings Gilbert White and Kingsley's "Glaucus," who showed us with the microscope the marvels in a drop of dirty pond water, and who on Saturday excursions up the river could talk of the Trilobites and the Orthoceratites, and explain the formation of the earth's crust. No more dry husks for me after such a diet, and early in my college life I kicked over the traces and exchanged the classics with "divers" as represented by Pearson, Browne, and Hooker, for Hunter, Lyell, and Huxley. From the study of nature to the study of man was an easy step.

My experience was that of thousands, yet, as I remember, we were athirst for good literature. What a delight it would have been to have had Chapman's "Odyssey" read to us, or Plato's "Phædo," on a Sunday evening, or the "Vena Historia." What a tragedy to climb Parnassus in a fog! How I have cursed the memory of Protagoras since finding that he introduced grammar into the curriculum, and forged the fetters which chained generations of schoolboys in the cold formalism of words. How different now that Montaigne and Milton and Locke and Petty have come to their own, and are recognised as men of sense in the matter of the training of youth.

Neither Montaigne nor Milton nor Locke had the wide national outlook on education displayed by Petty, who alone almost of his generation realised that the problems of natural philosophy, as it was then called, must be attacked in a systematic and co-operative study by a group of men "as careful to advance the arts as the Jesuits are to propagate their religion."

To come now to the subject-matter of my address—the earlier and more intensive study of science at school to save time at the university.

At fifteen years of age a boy should have had sufficient general education—the three R's, a fair knowledge of the history and literature of his country, and in the public schools enough classics to begin a technical training and to pass the ordinary entrance examination. Now comes the fateful period in which the bent of the boy's mind is determined. A difficulty exists in only a small proportion, a large majority have already selected careers, and the work of the sixteenth and seventeenth years should be determined by this choice, whether professional, commercial, academic, or the Services. The classical, modern, and scientific departments of the schools now meet these demands.

The profession of which I can speak is in a serious quandary. With the rapid development of science the subjects of study have become so multiplied that the curriculum is overburdened, and the five years is found to be insufficient. Men come up to the university later, remain longer, and the twenty-fifth or twenty-seventh year is reached before the qualification to practise is obtained. A measure of relief to this heavy burden—and it is one not likely to lighten during the next decade—is in your hands. Devote the sixteenth and seventeenth years to the preliminary sciences—physics, chemistry, and biology—and send us at eighteen men fit to proceed at once with physiological chemistry, physiology, and anatomy.

To do this three things are needed: teachers, laboratories, and a systematic organisation of the courses.

I put the personal first, as the man is more important than his workshop. Your association indicates the position which the science master has reached in our public schools, not without long years of struggle. The glamour of the classics lingers, but the shock which the nation has had in this great war will make us realise in the future that to keep in the van we must be in the van intellectually in all that relates to man's control of nature. Science "Heads" at Winchester, Eton, and Harrow would give the death-blow to the old-time Anglican tradition so well expressed in a Christmas sermon by the late Dean Gaisford, that classical learning "not only elevates above the vulgar herd, but leads not infrequently to positions of considerable emolument."

Brains, not bricks, should be the school motto in the matter of laboratories. A young Faraday in a shed is worth a dozen scientific showmen in costly buildings with lavish outfits. The accommodation, I am told, is at present ample in the larger schools. I have, indeed, seen laboratories which the most up-to-date college would envy. In the smaller schools it has not always been easy to get either the men, the space, or the equipment for teaching all the branches, and if an attempt is made to give earlier and more intensive science teaching there will have to be improvement all round.

The real crux is not with men or with buildings, but so to organise the teaching of the school as to have a continuous science course through two years. What is done now occasionally by the individual, I should like to see done by all the science men coming up to the universities or to the medical schools. The plan I urge would make a radical change in the constitution of some schools. Not that science is not taught and well taught, but it should be given its proper place, as the dominant partner in the educational family, not a Cinderella left in the kitchen. From an intellectual point of view the advantages are obvious. The mental exercise of the physical and mathematical sciences, combined with the technical training in the use of apparatus, gives a type of education singularly stimulating to boys. How many of our great inventors have lamented colourless careers at school! Things, not words, appeal to most boys. What an evolution of mind and hand is wrought by a year in a well-conducted physical laboratory. The fascination of making and fitting the apparatus, the wonders of electricity, and the marvellous laws of heat and light—into this new and delightful world a boy of sixteen may pass safely for a thorough training. Only it must not be a mere dabbling, to which the physical laboratory too often lends itself, but a serious day by day, week by week, gradual progress. The senior boys could keep their knowledge of the subject fresh by acting as demonstrators in the junior classes.

[1] From an address delivered to the Association of Public School Science Masters by the president, Sir William Osler, Bart., F.R.S., Regius Professor of Medicine, Oxford.

[2] Rev. W. A. Johnson, Warden and Founder of Trinity College School, Canada.

Many lads show an extraordinary aptitude for physics; there is always a boy Pascal in a big school, and no subject is so suited to arouse a fervid devotion to science. It would do the nation great good to have each generation, at the sixteenth or seventeenth year, pass automatically through a laboratory of physics.

I have spoken of the doubts expressed whether chemistry in the public schools can be taught at a college level. Of course it cannot if as a subsidiary subject, to which only a few hours a week are devoted, but in a course extending over two years, as a major subject, with laboratory work four or five mornings a week, surely a youth in his sixteenth and seventeenth years should be able to put in the foundation-stones, and in individual cases it is done already. As a mental discipline chemistry almost rivals physics; indeed, the new physical chemistry is a blend which appeals with magic potency to all science students.

But no subject attracts the young mind so strongly as biology, in its varied aspects. Elementary teaching is now admirably arranged, and in a two-year curriculum it should be an easy matter to cover much more ground than in the preliminaries demanded for medicine. Field classes in botany, gardens, museum work, should all be utilised. I would like to see at every school that excellent plan adopted by the late Sir Jonathan Hutchinson at his village museum, Haslemere—nature lectures on Sunday afternoons, with exhibition of the flowering plants of the season, with any other specimens of interest. The biology class gives an opportunity of a clear statement of the facts of sex, always so hard to discuss with boys.

There are objections, of course, to extensive and intensive teaching of science in schools. It is the business of the college, not of the school, to prepare boys for technical studies; but if it is the business of the school to teach science at all, why not teach it thoroughly? The general influence of the school may be trusted to counteract the evil possible in a too early concentration upon special subjects. Nature is never special, and a knowledge of her laws may form a sound Grecian foundation upon which to build the superstructure of a life as useful to the State, and as satisfying to the innner needs of a man, as if the groundwork were classics and literature. The two, indeed, cannot be separated. What naturalist is uninfluenced by Aristotle, what physician worthy of the name, whether he knows it or not, is without the spirit of Hippocrates? It has been well said that instruction is the least part of education. Upon the life, not the lips, of the master is the character of the boy moulded; and doubtless the great master of masters had this in mind when he said: "It may be, in short, that the possession of all the sciences, if unaccompanied by knowledge of the best, will more often than not injure the possessor." (Plato, "Alcibiades," ii.)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

LONDON.—Dr. H. M. Woodcock, assistant to the late Prof. E. A. Minchin, has been appointed acting head of the department of protozoology at the Lister Institute.

Applications for the Gilchrist studentship for women must be received by the Academic Registrar not later than February 29. The studentship is of the value of 100*l*., and is tenable for one year by a graduate in honours of the University of not more than three years' standing who is prepared to take a course of study in an approved institution for some profession.

A course of six lectures on the "Electrical Production of Nitrates for Fertilisers and Explosives" will be delivered this term, at University College, by Mr. E. Kilburn Scott. The first lecture, which is open to the public without fee or ticket, will be given on Wednesday, January 26, at 5.30 p.m. At the same college Dr. Marie Stopes will give a course of free public lectures on "Coal" on Tuesdays, at 5 p.m., beginning on January 18. These lectures are intended for advanced students in botany and geology, and for persons interested in mining.

FOUR lectures on "Dietetics" will be delivered on January 18–21, by Dr. H. Campbell, at Gresham College, Basinghall Street, London, E.C. The lectures are free to the public, and will begin each evening at six o'clock.

IT is announced in the issue of *Science* for December 17 last that a gift of 30,000*l*. to Harvard University with which to found a professorship in archæology is contained in the will of the late Mrs. E. M. Hudson, widow of a former president of the American Bell Telephone Company.

IT was stated in the issue of the *Times* of January 8 that the Maharani of Baroda has given 10,000*l*. for the permanent endowment of scholarships for deserving Hindu girls. Twenty-nine scholarships are provided for, and the remainder of the income will be devoted to a studentship for Hindu women who desire to study out of India.

THE annual meeting of the Geographical Association was held at University College on January 6. In the course of his presidential address, Mr. H. J. Mackinder laid great stress on the value and importance of maps in relation to the present crisis. He pointed out that a misrepresentation of ideas on a map was now a serious matter, not only to geographers, but also to the masses of the people; that, after the war, methods and subjects in education would have to be re-valued; that while scientific analysis in human geography could give assistance, every human distribution could not be explained by purely scientific reasoning; that the German idea of a road to the East *viâ* Bagdad was a magnificent one (and it could be represented on a map), but the idea required valuing as well as perceiving, and in that case the ocean route from Hamburg to India might prove to be equally important, even if less attractive at the moment; that one result of the war had been to make people think in maps and in continents in order to gain a proper perspective and right judgment of the course of events, hence the construction of maps and the cultivation of the map habit of thought should not form the end, but only the beginning of geographical studies. In a lecture on the geographical study of rivers, Dr. Marion Newbigin suggested that as geographers and geologists study the world from widely different points of view the geographer should lay stress on what most concerns his own subject, and should not accept materials chosen by the geologist. With regard to a river, the geologist describes it as a tool for modelling the land; hence the upper course is of the greatest interest to him, and he pays particular attention to abnormal features, such as the Niagara Falls and the Grand Canyon. To the geographer, however, the river provides lines of communication, suitable homes for man, and an outlet to the ocean; hence the middle and lower courses are mainly important to him.

THE statistics of public education in England and Wales for the year 1913–14 have been issued as a Blue-book [Cd. 8097]. In previous years the volume has been published in two parts, one of which dealt with financial statistics only, and this is not to appear this year. Nor is it intended to publish the usual

statistics for the year 1914–15. The present volume shows that for 1913–14 there were in England and Wales 1027 secondary schools on the Board of Education grant list, in which 10,824 full-time teachers and 3418 part-time teachers were employed. Of the former, 5447 were men and 5377 women. The schools educated 99,171 full-time boy pupils and 88,036 full-time girl pupils; while in addition 5802 part-time pupils were in attendance. Of the total number of schools on the grant list, 397 were for boys, 349 for girls, and at 281 both boys and girls attended. Of the full-time boy pupils 19,583 were under twelve years of age, 70,096 were twelve and under sixteen years of age, 8651 were sixteen and under eighteen years of age, and 841 were eighteen years of age and over. Of the total number of teachers 6829 were graduates and 3995 non-graduates. In addition to these secondary schools on the grant list, information is provided concerning 121 other schools which though efficient receive no aid from the Board. In these schools 13,618 boys and 8928 girls were taught. In a second Blue-book [Cd. 8098] the statistics of the Welsh schools included above are published separately. In Wales (with Monmouthshire) there were 117 schools on the grant list—30 for boys only, 29 for girls only, and 58 for boys and girls. The number of pupils in full-time attendance were: boys, 8,412; girls, 8757. In addition there were 814 part-time pupils on the roll. The staffs of the schools included 554 men and 460 women, exclusive of 278 part-time teachers. There were four efficient Welsh schools not on the grant list educating 112 boys and 296 girls.

The first volume [Cd. 8137] of the reports for the year 1913–14 from those universities and university colleges in Great Britain which are in receipt of grants from the Board of Education is before us. The reports are of special interest for two reasons; it is not intended to publish similar volumes for the year 1914–15, and the statistical information provided here relates to the last academic year before the outbreak of the war. In the introductory report, with which the volume opens, attention is directed to the loss of students and income which the universities have suffered as a result of the war, and to the additional assistance to meet such loss provided by the Treasury. A number of notable gifts and bequests made to university institutions during the year are recorded. These include, among others, a capital grant of 30,000*l*. received from the London County Council by the University of London for the extension and equipment of University College; 15,000*l*. from the Drapers' Company to defray the whole cost of the buildings and equipment of the chemical laboratories at East London College; 18,000*l*. from Sir George Kenrick for the endowment of a chair of physics at Birmingham University; 40,000*l*. from Messrs. G. A. and H. H. Wills for the University of Bristol; and 5000*l*. from Sir Joseph Jonas for a testing laboratory for the applied science department of Sheffield University. Interesting information can be gathered from the numerous tables. In England the total income from fees rose during the year by more than 6000*l*., that from endowments by more than 5000*l*., and the local authority grants supplied nearly 5000*l*. more than in the previous year. In England, again, the total expenditure of these institutions rose by about 15,000*l*. during the year. The total number of full-time students increased from 7666 in 1912–13 to 7756 in the year under review, an increase of 90. There was an increase of 37 students taking degree courses, and an increase of 36 in the number of students taking post-graduate courses.

SOCIETIES AND ACADEMIES.

Washington, D.C.

National Academy of Sciences (Proceedings, No. 12, vol i.).—L. T. **Sharp**: Salts, soil colloids, and soils. New light is thrown upon the subject of salts in relation with soil-colloids. The way is opened for extensive experiments in the physical chemistry of soils, and the principles involved will be of particular significance for the subject of the applications of "alkali" and of fertiliser salts.—Alice C. **Fletcher**: The child and the tribe. The rites connected with the initiation of the child into the tribal life are described with emphasis upon their significance in Indian education and philosophy.—H. S. **Washington**: The correlation of potassium and magnesium, sodium and iron, in igneous rocks. The author's earlier suggestion that soda not uncommonly tends to vary with the iron oxides while potash shows similar relations to magnesia is greatly strengthened by a compilation of analyses of igneous rocks, numbering nearly 10,000.—G. D. **Birkhoff**: Theorem concerning the singular points of ordinary linear differential equations. It is shown that transformations of the independent variable have no significance over and above linear transformations of the dependent variables for the purposes of classification with respect to the notion of equivalence.—D. I. **Macht**, N. B. **Herman**, and C. S. **Levy**: A quantitative study of cutaneous analgesia produced by various opium alkaloids. By the use of exact experimental methods the order of analgesic power in the individual alkaloids from strongest to weakest is found to be:—Morphine (10 mg.), papaverine (40 mg.), codeine (20 mg.), narcotine (30 mg.), narceine (10 mg.), thebaine (10 mg.). The combinations of alkaloids are also studied.—W. D. **Harkins** and E. C. **Humphery**: The surface-tension at the interface between two liquids. The substitution of experiments on the liquid-liquid interface for the ordinary method in which a liquid-air interface is used, makes it possible to compare the drop-weight results with those obtained in a capillary tube of large bore. Various advantages appear from the use of this method.—W. H. **Wright**: Outline of a proposed system of classification of the nebulæ by means of their spectra. The spectra are arranged according to the degree of concentration of 4686Å, and some of the neighbouring lines. The successive nebulæ stand in very close relation to one another, yet at one end of the scale is a purely gaseous nebula, and at the other a banded star.—W. H. **Wright**: Some probable identities in wave-length in nebular and stellar spectra. The evidence renders probable the presence in the nebulæ of carbon and nitrogen, and fortifies the assumption of a close relationship between the nebulæ and the early type stars.—F. G. **Benedict** and H. **Murschhauser**: Energy transformations during horizontal walking. The metabolism found for the subject walking at moderate speed without food has an average value of 1/2 gram-calorie. Slow, medium, and fast walking, and running are investigated for comparison. —F. G. **Benedict** and F. B. **Talbot**: The physiology of the new-born infant. The results of experiments on 105 new-born infants give opportunity for suggestions as to supplemental feeding and methods of conserving energy.—T. M. **Carpenter**: A comparison of methods for determining the respiratory exchange of man. The apparatus compared were the following: bed respiration calorimeter; two forms of the Benedict universal respiration apparatus; Zuntz-Geppert apparatus; Tissot apparatus: and so on.—R. **Dodge** and F. G. **Benedict**: Neuro-muscular effects of moderate doses of alcohol. Contrary to the theory of Kraepelin, the authors find no facilitation of the motor processes, but the depression of their simplest forms in the finger- and eye-movements seem to be one of the most characteristic

effects of alcohol.—Ruth J. **Stocking**: Variation and inheritance in abnormalities occurring after conjugation in *Paramecium caudatum*. In respect to the abnormalities, while some lines are constant in hereditary character, in others hereditable variations do occur within the line, so that, by selection, it is possible to break the single stock into a number of stocks differing hereditarily.—L. R. **Cary**: The influence of the marginal sense organs on functional activity in *Cassiopea zamachana*. There is no direct relationship between the extent of muscular activity and the rate of regeneration. In the absence of the influence of the sense-organs regeneration can take place normally but always at a decidedly lower rate.—A. R. **Middleton**: Heritable variations and the results of selection in the fission rate of *Stylonychia pustulata*. It is possible to give precise data as to the occurrence of heritable variations and their accumulation through selection; and this can scarcely fail to have influence on the conception of the genotype as a fixed thing.—H. **Cushing**: Hereditary anchylosis of the proximal phalangeal joints (symphalangism). The character behaves as a simple Mendelian dominant with equal chance among the offspring of affected individuals that it will be or will not be inherited.—S. O. **Mast**: The relative stimulating efficiency of spectral colours for the lower organisms. The stimulation in all of the organisms studied depends upon the wave-length of the light, and the stimulating efficiency is very much higher in certain regions of the spectrum than in others, but the regions differ in certain organisms closely related in structure.—W. M. **Davis**: The Mission Range, Montana. This range seems unique in its systematic tripartite arrangement of normally and glacially sculptured forms.—E. H. **Moore**: Definition of limit in general integral analysis. The definition is noteworthy in that it involves no metric features of the range $\mathfrak{P}$ underlying the range of definition of the function $F(\sigma)$.

NEW SOUTH WALES.

Linnean Society, November 24, 1915.—Mr. A. G. Hamilton, president, in the chair.—R. J. **Tillyard**: Studies on Australian Neuroptera. No. I.—The wing-venation of the Myrmelionidæ. The tracheation of the pupal wing was obtained by dissecting off the wing-sheaths of the newly-formed pupa, and making photomicrographs from them in water. The forewing offers a very interesting condition, inasmuch as it is found that the supposed main stem of the cubitus (Cu_1) is really the lower branch of the media (M_2), except for a small basal portion. For this compound vein, the name *cubito-median* (Cu_1+M_2) is proposed. The passage of M_2 over to Cu_1 in the imago is marked by a *persistently oblique* cross-vein, similar to that marking the bridge in Odonata. In the hindwing, the media is unbranched, and the venation follows the tracheation exactly. The peculiar formation called the "Banksian line" is also studied and explained, and is contrasted with the "gradate series" of Chrysopidæ. Finally, the phylogenetic interpretation of the results is shown to point to the descent of the Myrmelionidæ from ancestors similar to the present Australian Nymphidæ—a conclusion that can also be arrived at by a study of other organs, larval forms, and habits.—Miss A. A. **Brewster**: Observations on the pollination of *Darwinia fascicularis*. Among the generic characters of Darwinia, Mr. Bentham gives "Style exserted, usually long, and more or less bearded towards the end" ("Fl. Aust.," iii., 6). By the late Mr. E. Haviland, the bearded portion was thus described:—"Immediately below the stigma is a ring of stiff hair-like glands, which secrete an adhesive fluid copiously" (Proc. Linn. Soc., N.S. Wales, 1884, p. 70); and pollination was ascribed to insect-agency. It is now shown, (1) that the hairs serve the purpose of entangling and storing the viscid pollen, which is shed from the anthers when the perianth opens to allow of the exit of the young, elongating style; (2) that the flowers are pollinated by nectar-seeking birds; and (3) that the process is facilitated by the condition that, in almost every cluster of flowers (6–12), there is a distinct zone of mature, or almost mature, pistils, representing about one-half of the cluster, while those of the other half are in bud or in some intermediate stage of development; so that flowers of the same cluster may offer elongated styles with stigmas ready for pollination, as well as shorter styles with pollen-masses ready for transfer.—R. **Greig-Smith**: Contributions to our knowledge of soil-fertility. No. XIV.—The stimulative action of traces of chloroform retained by the soil. When a soil is treated with chloroform and then exposed to the air, traces of the volatile disinfectant are retained by the soil. These stimulate the growth of bacteria in soil-extracts. The action of volatile disinfectants upon the soil is, therefore, in part due to the direct stimulation of the soil-bacteria by traces retained by the soil.—E. W. **Ferguson**: Revision of the Amycterides. Part IV.—Sclerorinus (section ii.). Section ii. comprises four groups. Group i. (sixteen species) is well represented in South Australia, extending also to north-west Victoria, Central Australia, and the Murchison district of Western Australia. Group ii. (seven species) includes species which occur along the highlands of Queensland and New South Wales, and two which extend to Victoria, Tasmania, and South Australia. Group iii. (five species) is distributed over the southern tablelands of New South Wales. Group iv. (fifteen species) is strongly represented in South Australia, with a few species extending to Victoria, New South Wales, and Queensland. Five species are described as new; and two, previously described, are regarded as anomalous, and left ungrouped.—F. H. **Taylor**: Australian Tabanidæ. No. I. Eight species of Silvius (subfamily Pangoninæ) are described as new, increasing the total number of described species to fourteen. Only two of these are known to occur south of the tropic of Capricorn.

BOOKS RECEIVED.

Le Scuole Ionica Pythagorica ed Eleata (I Pre-aristotelici 1). By A. Mieli. Pp. xvi+503 (Firenze: Libreria Della Voce.) 12 lire.

Bacon's Contour Atlas. Northern Wales Edition. Pp. 41. East Anglia Edition. Pp. 41. South-West England Edition. Pp. 41. (London: G. W. Bacon and Co., Ltd.) Each 6*d*. net.

The Cosmogony Actual: a Statement of Certain Stresses in Stellar Physics. By A. R. Ward. Pp. 68. (Sydney: W. Brooks and Co., Ltd.)

The Prophecy concerning the Rōsh Kelālāh. By A. R. Ward. Second edition. Pp. 58 (Sydney: W. Brooks and Co., Ltd.) 1*s*. 6*d*.

National Efficiency. A Series of Lectures delivered by Prof. R. F. Irvine, M. Atkinson, Prof. W. H. Moore, and Prof. W. A. Osborne, at the Victorian Railways Institute in August-September, 1915. Pp. 56. (Victorian Railways Printing Branch.)

Land and Marine Diesel Engines. By Prof. I. G. Supino. Translated by Eng.-Lieut.-Com. A. G. Bremner and J. Richardson. Pp. xv+309. (London: C. Griffin and Co., Ltd.) 12*s*. 6*d*. net.

An Elementary Grammar of Colloquial French on Phonetic Basis. By Prof. G. Bonnard. Pp. xii+180. (Cambridge: W. Heffer and Sons, Ltd.) 3*s*. 6*d*. net.

The Magic of Jewels and Charms. By Dr. G. F. Kunz. Pp. xv+422. (Philadelphia and London: J. B. Lippincott Co.) 21*s*. net.

How to Make Low-Pressure Transformers. By

Prof. F. E. Austin. Second edition. Pp. 17. (Hanover, N.H.: F. E. Austin.) 40 cents.

Medicinsk-Historiske Smaaskrifter, 12: Enkjorningen. By A. Garboe. Pp. 119. (Kobenhavn: V. Trydes Forlag.)

Eight Lectures on Theoretical Physics, delivered at Columbia University in 1909, by Prof. W. Planck. Translated by Prof. A. P. Wills. Pp. ix+130. (New York: Columbia University Press.)

Four Lectures on Mathematics delivered at Columbia University in 1911. By Prof. J. Hadamard. Pp. v+52. (New York: Columbia University Press.)

The Rat: Reference Tables and Data for the Albino Rat and the Norway Rat. Compiled and edited by H. H. Donaldson. Pp. iii+278. (Philadelphia: Wistar Institute of Anatomy.) 3 dollars.

Memorial Volume of the Transcontinental Excursion of 1912 of the American Geographical Society of New York. Pp. xi+407. (New York: American Geographical Society.) 3 dollars.

Manual of the New Zealand Mollusca, by H. Suter. Atlas of Plates. 72 plates, with descriptions. (Wellington, N.Z.: J. Mackay.)

A Budget of Paradoxes. By A. de Morgan. Second edition. Edited by D. E. Smith. 2 vols. Vol. i., pp. viii+402. Vol ii., pp. 387. (Chicago and London: The Open Court Publishing Company.) 30*s*. net.

The Embryology of the Honey Bee. By Dr. J. A. Nelson. Pp. 282+plates. (Princeton: Princeton University Press; London: Oxford University Press.) 8*s*. 6*d*. net.

Occasional Papers of the Boston Society of Natural History. vii.: Fauna of New England. 13: List of the Mollusca. By C. W. Johnson. Pp. 231. (Boston, Mass.)

Reports for the Year 1913–14 from those Universities and University Colleges in Great Britain which are in Receipt of Grant from the Board of Education. 2 vols. Vol. i., pp. xxxiii+554. Vol. ii., pp. 518. (London: H.M.S.O.; Wyman and Sons, Ltd.) 2*s*. 4*d*. and 2*s*. 1*d*. respectively.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 13.

ROYAL SOCIETY OF ARTS, at 4.30.—The Romance of Indian Surveys: Sir T. H. Holdich.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Predetermination of the Performance of Dynamo-electric Machinery: Prof. Miles Walker.

MATHEMATICAL SOCIETY, at 5.30.—The Transition from Vapour to Liquid, when the Range of the Molecular Attractions is Sensible: Sir J. Larmor.—(1) A Note on the Uniform Convergence of the Fourier Series $\Sigma a_n \sin n\theta$; (2) A Condition for the Validity of Taylor's Expansion: T. W. Chaundy.—The Average Order of the Arithmetical Functions $P(x)$ and $\Delta(x)$: G. H. Hardy.—Green's Dyadics in the Theory of Elasticity: C. E. Weatherburn.—A Problem in "Analysis Situs": G. N. Watson.

FRIDAY, JANUARY 14.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Occultations of Stars by the Moon, observed at the University Observatory, Warsaw, 1914–15: S. Tscherny.—(1) 8th Note on the number of faint stars with large proper motions; (2) The distribution in space of the stars in Zone +25° of the Oxford Astrographic Catalogue: R. J. Pocock.—Real Paths of 250 Fireballs and Shooting Stars observed in the British Isles during the four years 1912 to 1915 inclusive: W. F. Denning.—Note on lines of Silicon in the Spectra of B Stars: A. Fowler.—The R—D discordance of the Greenwich transit-circle, Royal Observatory, Greenwich.

MALACOLOGICAL SOCIETY, at 7.—The Operculum of the Genus Bursa (Ranella): Rev. A. H. Cooke.—The Shells of the South African Species of Lepidæ: E. A. Smith.—(1) A Volume of Plates Prepared by Rackett for the Second Edition of Pulteney's "Dorsetshire Shells" in Hutchin's "History of Dorset"; (2) Lovell Reeve's "Elements of Conchology," with some Dates of Publication: A. Reynell.

TUESDAY, JANUARY 18.

ROYAL INSTITUTION, at 3. The Physiology of Anger and Fear: Prof. C. S. Sherrington.

ROYAL STATISTICAL SOCIETY, at 5.15.

INSTITUTION OF PETROLEUM TECHNOLOGISTS, at 8.—Oil Storage: H. Barringer.

MINERALOGICAL SOCIETY, at 5.30.—A Simple Demonstration of the Law of Miller: Prof. G. Cesàro.—The Meteorite of Daniels Kuil: Dr. G. T. Prior.—The Relationships of Meteorites: Dr. G. T. Prior.—The Isolation of the Directions-image of a Section of a Mineral in a Rock-slice: Dr. J. W. Evans.—A New Method of Determining the Angular Direction Represented by a Point in the Directions-Image: Dr. J. W. Evans.—A New (Seventh) List of Mineral Names: L. J. Spencer.

WEDNESDAY, JANUARY 19.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Presidential Address: Winter Climate of the Eastern Mediterranean: Major H. G. Lyons.

GEOLOGICAL SOCIETY, at 5.30.

ROYAL SOCIETY OF ARTS, at 4.30.—The Common Lands of London: The Story of their Preservation: L. W. Chubb.

ENTOMOLOGICAL SOCIETY, at 8.

THURSDAY, JANUARY 20.

ROYAL INSTITUTION, at 3.—The Utilisation of Energy from Coal: The Chemistry and Economics of Coal and its By-Products: Prof. W. A. Bone.

LINNEAN SOCIETY, at 5.—The Definition of "Right" and "Left" in relation to Coiled, Rolled, Revolving, and Similar Objects: a Problem in Scientific Terminology: Miller Christy.—Some Aspects of the Bagshot Sands Flora: H. W. Monckton.—Colour-photographs of Mollusca: B. B. Woodward.

ROYAL GEOGRAPHICAL SOCIETY, at 5.—The Middle Tees and its Tributaries: C. B. Fawcett.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Principles of Modern Printing Telegraphy: H. H. Harrison.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Principles of Modern Printing Telegraphy: H. H. Harrison.

FRIDAY, JANUARY 21.

ROYAL INSTITUTION, at 5.30.—Problems in Capillarity: Sir James Dewar.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—The Flow of Air through Nozzles: Capt. T. B. Morley.

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THURSDAY, JANUARY 20, 1916.

ARC LIGHT.

Electric Arc Phenomena. By Ewald Rasch. Translated from the German by K. Tornberg. xvi + 194 pp. (London: Constable and Co., Ltd., 1915.) Price 8*s*. 6*d*. net.

THIS book surprises the reader by its extraordinary inequality: its excellencies in some directions and its absolute badness in others. Either the author, who is understood to be a professor at Potsdam, is amazingly ignorant of scientific and technical progress outside Germany, or else he suppresses the work achieved by discoverers in other nations. And his translator, who is apparently American, makes no attempt to remedy the very obvious limitations of the author: he not even attempts to reclaim for American pioneers in arc lighting—Elihu Thomson, Brush, Steinmetz, and more recent workers—the credit which is justly theirs. As for English investigators of the electric arc, they are almost all ignored except Mrs. Ayrton, whose work the author does not altogether understand, and Prof. Silvanus Thompson, to whom he gives more credit than that industrious person ever claimed. His historical methods are peculiar. For example, when referring to Davy's early accounts of his experiments on taking spark discharges from a voltaic pile between electrodes of charcoal—experiments which certainly did not begin before the invention of the pile in 1800—he quotes a passage in the first person from Priestley's "History of Electricity," so making Priestley, whose last edition was in 1794, responsible for Davy's words. Again, referring to the commercial impossibility of applying the arc for electric lighting so long as a battery of voltaic cells was the only available source, the author, oblivious of Holmes's success in establishing electric lights in lighthouses by means of currents generated by an alternator, oblivious, too, of Faraday's report and lecture thereon in 1862, makes the following absurd statement:—

"But it was not till seventy years later" [than Volta's discovery of 1800] "that the electric arc could become of practical importance as a source of light, when, thanks to the invention of the dynamo by Werner von Siemens, Hefner Alteneck, and others, a convenient and economical source was provided, which substituted electrodynamic action for the electrochemical action of galvanic primary cells."

It is true that in 1867 Werner von Siemens invented a particular form of dynamo, and that in 1873 Hefner Alteneck introduced modifications of the winding of armatures. These improvements scarcely justify such sweeping claims in their favour, or the ignoring of Wilde, Holmes, and Gramme. Again, it is foolish to claim for Davy, as the author does on p. 4, the employment of "a series resistance," and "the selection of a suitable voltage" to produce stable flame discharges. Some of the alleged facts as to arcs cause us to rub our eyes and wonder whether the author, who again and again quotes himself as having taken out various patents on arc lighting, has ever verified them. For instance, he alleges that heat conduction along the carbons is responsible for a waste of 79 per cent. of the energy supplied to the arc. Also he asserts (on the authority of Arons) the impossibility of maintaining an alternating arc between metallic electrodes on account of their great thermal conductivity—an assertion abundantly contradicted by the researches of Pfund, and arc-furnace experience. The author seems to think that the starting of an arc by any other process than bringing the tips of the carbons into contact and then parting them was unknown until he discovered other ways in 1899; and that these other ways are of an importance comparable with the usual contact method. His investigations on the possible use of kathodes consisting of hot metallic oxides and other solid electrolytes are doubtless a useful contribution to knowledge: but they scarcely justify his attitude towards Wehnelt.

On p. 11 the author declares that a stable arc is possible, and can be maintained, only when the kathode surface has a sufficiently high temperature: yet on p. 163 we discover that even comparatively cold liquids, aqueous solutions, and fused salts are excellent kathodes, and are capable of producing surprisingly beautiful arcs. His definition of an arc is as follows:—"Broadly speaking, one must designate as an electric arc any continuous discharge occurring between electrodes of different potential and serving as a source of light, where at least one of the electrodes—the kathode—is kept at a high temperature either by the current passing or by auxiliary means." According to this definition a Duddell arc which serves, not as a source of light, but as a generator of oscillations, is not an arc. The author states that the anode crater acts, "in a sense," as a reflector upon which the kathode radiates its heat. Since the crater anode is hotter, and emits twenty times as much light as the tip of the kathode, its action as a reflector can only be admitted in a very special sense indeed.

The instructions which the author gives on pp. 19–21 for adjustment of the arc seem to miss

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some essential points. The advice to try always to adjust the arc "by means of the series resistance alone" is ambiguous. To adjust the arc to normal length, and to adjust the arc to take the correct current, are two different matters, and require recourse to different means.

There is an extraordinary dictum on p. 39:—"The close relation between the specific heat of a luminous layer and the radiation thereof is evident, since the efficiency of a luminous body increases rapidly with its temperature." This betrays a strange confusion of thought. The specific heat of a substance is indeed of importance during the period when its temperature is rising. But when the high temperature of incandescence has once attained its steady value, the specific heat of a material has *per se* no more influence on its efficiency of radiation than has its price in the market.

In dealing with Mrs. Ayrton's careful investigation of the relations which subsist in the continuous current arc between arc length, current, and potential difference across the arc, the author is often obscure. He seems to have no grip of the distinction between a dependent variable and an independent one. Thus it appears from Mrs. Ayrton's work that if a current of 10 amperes is passed through an arc (using solid carbons) 5 millimetres long, the arc voltage is about 56 volts, and remains at that figure if length and current are maintained constant. Also that if a current of 8 amperes is passed through an arc 4·5 millimetres long, the arc voltage is still 56 volts. But though the voltage thus appears to be constant, it does *not* follow that on a circuit maintained at 56 volts the current will adjust itself to 10 amperes if the carbons are set to a distance of 5 millimetres. On the contrary, assuming that these values could be momentarily attained, the current would at once increase a little, thereby lowering the resistance of the arc, and with lowered resistance the current would increase still more, and the rush of current will be enormous unless a steadying resistance is introduced into the circuit. The phenomena are perfectly well known, but the interpretation might be more clearly stated if it were plainly recognised that the arc voltage is *not* an independent variable. Incidentally the author points out that J. Stark has shown that spark discharges of not too great length follow a law of the same form as that which Silvanus Thompson gave for the arc, namely $e=m+C/I$; where m is the voltage for minimum length and C the watts per ampere, which for given materials is nearly constant.

The author devotes several pages to the theory of stability of the arc, and comes to the strange conclusion that for every (carbon) arc there is a maximum potential difference across the arc beyond which the arc will extinguish itself, namely that which is exactly half-way between the minimum voltage (about 36½ volts for carbon arcs) and the voltage of supply. If this is true then on 100-volt mains the maximum possible voltage would be 68¼ volts, and the efficiency necessarily limited to 68¼ per cent. Another strange conclusion is that the numerical values obtained by Mrs. Ayrton for the carbon arc are valid only in connection with the particular generator which she used! The author repeats, in the chapter on the distribution of energy in the arc, the opinion that for electrodes the substances used should have a low specific heat, declaring this to be "a physical quantity of paramount importance on the luminous efficiency" of glowing solids, and saying that this accounts for the high efficiency of the osmium lamp. It is difficult to attach a coherent meaning to this, or to the statement (p. 124) that "when an arc increases in length its cross-sectional area does not remain constant, as Ohm's law presupposes." Why should Ohm's law presuppose any such nonsense? The author claims for Bremer in 1899 the utilisation of the introduction into arc carbons of metallic salts that colour the arc, and hints not obscurely that he himself was the discoverer of this property in 1892. He ignores the circumstance that Gaudoin published accounts of this manufacture in 1875.

The author interpolates in the chapter on the distribution of energy in the arc a diatribe against Maxwell's electromagnetic theory of light—"a theory long since exploded"—which "has never been productive of the least progress in the theory or technology of light generation." He lauds Minkowski's four-dimensional theory of relativity. He sets up Weber as advocating Newton's corpuscular theory of light, and claims "as a matter of national pride" to point out that the Germans Weber and Planck have corrected the inaccuracies of those who attempted to apply Maxwell's theory to experimental facts. Everyone who advocated the undulatory theory of light was, it appears, wrong.

"This strife could easily throw a dismal light on the great of our nation. Blind animosity has characterised this combat, surcharged with malice. Even Goethe has taken part therein, as is evident by the very way he mentions the name of Newton."

We can only ask, and in a double sense, *is he dead?*

"VIGOUR" AND "INSTINCT."

(1) *Vigour and Heredity.* By J. L. Bonhote. Pp. xii+263. (London: West, Newman and Co., 1915.) Price 10*s.* 6*d.* net.

(2) *Instinct and Intelligence.* By N. C. Macnamara. Pp. 216. (London: Henry Frowde and Hodder and Stoughton, 1915.) Price 6*s.* net.

(1) IN his experience as a breeder and naturalist Mr. Bonhote has been confronted with the difficulties presented by many of the facts of inheritance. Mendel's law holds good in some cases, Galton's law in others, but many facts seem unconformable, and a consideration of these has led him to a theory of "vigour." By vigour he means "activity of nutrition and function" or "the rate of metabolism," and his theory is that the "initial vigour" of an organism, which in part determines the expression of its inheritance, depends upon the vigour of the parents at the time of reproduction.

The author is in error in thinking that "we have no method of definitely ascertaining or measuring the rate of metabolism," for we can use the absorption of oxygen or the output of carbon dioxide as an index. In default of this, an attempt is made to estimate vigour indirectly "by actions, colour, and condition," and this means slippery ground on which the author does not always keep his feet. By a multitude of interesting illustrations, however, he seeks to show that temperature, humidity, and food supply influence vigour, and through vigour coloration. Thus colour becomes "our best and at the present time our chief index of vigour." It is plain, however, that a brief intensity of metabolism might lead to an abundant production of pigment, and that the organism might thereafter settle down to a humdrum sluggishness indicative of anything but vigour.

Mr. Bonhote adopts the reasonable view that a radical physiological difference in metabolism distinguishes the sexes, but he states the idea too crudely when he simply calls the male katabolic and the female anabolic. According to "The Evolution of Sex" (1889), to which he refers many times, the fundamental physiological difference between the sexes lies in the *relative* predominance of anabolism or katabolism in the metabolic processes. Constructive processes, notably those that have to do with the upbuilding of proteids, must, of course, always exceed disruptive processes so long as the organism continues to be a going concern, but the "Evolution of Sex" thesis was that the *ratio* of anabolism to katabolism is characteristically greater in females than in males, and conversely. Mr. Bonhote prefers to conceive of the fundamental difference as depending on the *rate* of intensity of metabolism, and unfortunately he sometimes uses the concept of metabolism too narrowly (*e.g.*, on p. 244), as if it had simply to do with assimilation processes. In this connection it may be noted that, according to the author, high vigour in the parents tends to a predominance of females among the offspring (though the opposite seems to have been inadvertently stated in the last sentence of chapter v.).

The central idea of the book is that the environment in the widest sense affects vigour (defined as rate of metabolism), that the vigour of the parents at the time of reproduction "is reflected to a greater or less extent in the vigour" (here used in a rather different sense!) of the sex-cells, and therefore in the vigour of any determinant in the inheritance. The development of characters is thus influenced by the vigour of the parents, and also, the author maintains, by the nurture (in the widest sense) of the developing individual. Mr. Bonhote knows that he has not proved his theory, and we are afraid that it will not admit of proof until its terms are made more precise, but attention must be directed to the hundred pages in which the author describes his breeding experiments, conducted *con amore* and under difficulties, on goats, cats, rats, pigeons, and ducks (of which there are three very fine plates), and expounds without any dogmatism the facts that have led him to the conviction that environment affects the physiological condition of the parent, and may have some influence on the characters of the offspring.

(2) Dr. Macnamara takes an interesting survey of the chief modes of animal behaviour, and shows how much there is—from amœba to man—that deserves to be called purposive, though it cannot be called intelligent. In the higher animals the hereditarily engrained instinctive capacities have their seat in the basal ganglia, while the intelligent capacities are localised in the upper regions of the cerebral cortex, notably in the "neopallium" of mammals. The author's thesis is that in human education too little attention is given to the phylogenetically older instinctive impulses and emotions, and relatively too much to trying (not very successfully) to train the intellect. What he advises is that more care should be given to discovering what in each child are the strongest instinctive qualities and adjusting the education thereto; that teachers should know more about the physiology of the nervous system; that there should be more sensory experience at a high level; that exercises in control should be devised;

and that the instincts should be linked on to reason and the finer feelings so that the best in us may inhibit the worst.

The author makes a useful biological contribution to the problem of education, and has a wholesomely strong faith in the importance of "nurture," in the widest sense, in developing the individual's hereditary "nature." We would point out, however, that while Dr. Macnamara starts with Lloyd Morgan's clear-cut conception of instinct, he does not consistently adhere to it, and often uses the term instinctive very loosely; that he seems at times to exaggerate the separability of instinctive and intelligent faculties in children, for they seem to us to be very intimately blended; and that he gives glimpses of a quite untenable theory of energy overflowing or irradiating from one part of the nervous system to another so as to maintain a state of equipartition.

Dr. Macnamara was investigating and writing half a century ago, and we do not wonder that he has overlooked a number of typographical errors, such as "philogenetic," and "exasperating sway" (of women) instead of "way," but he should not have passed a sentence like this:—"The Hydromedusæ present two main forms, the non-sexual polyps or Hydra, and the sexual Medusæ, such as jelly-fish and sea anemones." Here there are at least three mistakes. Nor can we accept the statement that the male stickleback cements grass-stalks together with a layer of mucus exuded from the surface of his body.

INTRODUCTORY TREATISES ON MECHANICS.

(1) *An Introduction to Applied Mechanics.* By E. S. Andrews. Pp. ix+316. (Cambridge: At the University Press, 1915.) Price 4*s.* 6*d.* net.

(2) *An Introduction to the Mechanics of Fluids.* By Prof. E. H. Barton. Pp. xiv+249. (London: Longmans, Green and Co., 1915.) Price 6*s.* net.

(3) *Experimental Physics: A Text-book of Mechanics, Heat, Sound, and Light.* By Prof. H. A. Wilson. Pp. viii+405. (Cambridge: At the University Press, 1915.) Price 10*s.* net.

WRITERS of mathematical text-books on mechanics and of so-called applied mechanics have still much to learn from one another. A too excessive abstract and logical development of the subject by the one tends to make the student lose the sense that it deals with real things; while evident striving for ultra-practicality by the other, and the looseness and inaccuracy of statement often combined with it, irritate him. On the one hand the ordinary student is bored, and on the other puzzled to death. For the difficulties which the industrious student of average ability experiences are more frequently than otherwise due to the fact of his having too logical and clear a mind, or rather perhaps to possessing a mind which requires logical presentment. To a certain extent the three books before us illustrate the above remarks in one direction or the other.

(1) That the first author would generally agree with them is apparent from his remarks in the preface that the older form of text-book was too much a kind of exercise ground for algebraic manipulation, and that many of the more modern give too much engineering application of the principles without sufficient explanation of those principles. And yet in reading through his attempt to strike the happy mean, one is constantly meeting statements which, though not quite wrong, are certainly not quite right. The following are a few samples. On p. 18 the principle of moments follows from Newton's first law of motion, because, since it does not change its state of rest, there is no tendency to rotate about any point. Two pages before it was given as a definition that this tendency is measured by the moment. It requires some thought on the part of the student to find that really he has been deceived into thinking that the principle is proved. On p. 17, "so long as we deal with forces in one plane, moments are scalar quantities." The student is brought to a stop with the query why the scalarity of the moment of a force should depend on the nature of other forces with which it has nothing to do. (Owing to an oversight also here the example given does not agree with the direction of the forces in the diagram.) On p. 40 "we may point out that when in ordinary parlance we speak of power we really mean energy." On p. 139 "stress may be defined as the force between the molecules of a body brought into play by the strain." On p. 124 "inertia is the property of a body which resists a change of motion" recalls Maxwell's classical illustration of this statement by a cup of tea resisting being sweetened by the sugar put into it. It is difficult to see what object is gained by the elaborate drawing of a steamboat on p. 45, or of a traction engine and track on p. 127.

In spite of these defects, the book can be recommended for use by engineering students. The substance is well chosen and the treatment adequate. A student who has mastered it should have a good working knowledge of the dynamical principles underlying every engineer's work. The first eight chapters are an introduction to

dynamical principles. Chapters ix.–xii. deal with stresses and strains in joints, frames, and girders; chaps. xiii.–xv. with centres of gravity, friction, and curved paths; and the last with mechanisms.

(2) This introduction to the study of fluids is intended "for candidates for entrance scholarships and other examinations, for naval and military preparation, for those technical students taking the Board of Education lower examination in theoretical mechanics (fluids), or any of a similar character held by the various provincial educational unions." For these purposes it would seem to be an adequate and sound presentation of the subject. In addition, it will also serve to give the student a sound knowledge of the subject—a result almost as important. Part i., on the mechanical basis of the subject, might possibly have been omitted with advantage as the majority of students would come to the study of fluids with a preliminary knowledge of dynamics from other sources. The succeeding parts deal with liquids at rest, in motion, properties of gases, and finally with applications. This last contains a valuable addition to the usual list of old friends, and deals with a number of recent inventions of special interest as illustrating principles. The book affords an excellent example of the combination of logical development and exactness of ideas with the stimulating effect aroused by dealing with real problems.

(3) The scope of this book is best shown by the following extracts from the preface. "This book is intended as a text-book for use in connection with a course of experimental lectures." "The aim of the writer should be to present fundamental principles clearly and accurately." "I have endeavoured to leave out everything not of fundamental importance." "The kind of text-book which contains a little about everything does more harm than good." It is thus seen how much the intention of the author differs from that of the generality of writers of text-books for first year and elementary students. The result is a very clear and excellent introduction to the subject of mechanics, properties of matter, heat, sound, and light, suitable to the needs of university students in their first year and taking curricula for pure science, medicine, or applied science. It is a book for which examinations should be suitable, laying sound foundations for future developments in greater or less degree as may be required for the more specialised curricula of the second and third years. Where an effort has been made to circumscribe the field, differences of opinion may arise as to whether it may not have been carried too far, but each individual teacher can always remedy this in the case of his own students. For example, it may be doubtful if it is desirable to leave out all consideration of radiation or whether more application of principles to explain common and everyday experiences might not have been given with advantage—in spite of the fact that to the author such things may be hackneyed.

No sets of examples for exercise are given. This is a disadvantage for private students. Any competent teacher giving a course of experimental lectures will have his own selection. To such the book can be confidently recommended. It has the good paper, printing, and clearness expected from the Pitt Press. It is curious to see in a book printed in an English University a statement that thermometers may be standardised by sending them to the Bureau of Standards at Washington, U.S.A., or similar institutions in other countries. In another edition the explanation of the total reflection of the ordinary ray in a Nicol's prism should be amended. Also the melting-point of sodium thiosulphate ("hypo") is not 9·9° C.

OUR BOOKSHELF.

A Course in Invertebrate Zoology. A Guide to the Dissection and Comparative Study of Invertebrate Animals. By Prof. H. S. Pratt. Revised edition. Pp. xii + 228. (Boston and London: Ginn and Co., 1915.) Price 6*s*.

THIS book is intended as a guide to the study of each of the larger groups of invertebrates. About forty animals are considered in the space of 196 pages, consequently the descriptions of many of them—clear so far as they go, and accurate, the lapses being few and of little moment—are brief, though several, *e.g.* the squid, are more fully treated. The chapters deal respectively with the arthropoda, annelida, flat worms, polyzoa, mollusca, tunicates, echinoderms, Cnidaria, sponges, and protozoa. The revised edition contains instructions for the examination of six types not included in the first edition, namely, a fly, spider, oyster, sea-cucumber, Gonionemus, and a sea-anemone. In the account of the fly attention is directed to the "antennæ, with their pinnate terminal portion" (the portion referred to—the arista—is, however, not terminal but dorsal), but the palps are not mentioned, and no attempt is made to elucidate the structure of the proboscis.

In the classification given in the appendix the sponges are classed with the Cnidaria as cœlenterates—implying a relationship which modern work has shown to be untenable; another obsolete feature is the retention of the "phylum" Vermes to include a heterogeneous assemblage of animals —flat and round worms, rotifers, polyzoa, brachiopods, Phoronis, Chætognatha and Sipunculoidea (the annelids are placed in a separate phylum).

Vicious Circles in Sociology and their Treatment. By Dr. J. B. Hurry. Pp. 34. (London: J. and A. Churchill, 1915.) Price 2s. net.

THIS little book, planned on the lines of the author's "Vicious Circles in Disease," is intended to emphasise that, just as in disease, so in social life, various pernicious factors are at work which act and react upon one another, constituting a "circle." Thus crime leads to loss of employment, which leads to loss of means of subsistence, which again begets crime, and tuberculosis leads to poverty, and poverty is a potent factor in the causation of tuberculosis. The author recognises ten such circles met with in sociology, and while they may act separately, several of them may be in simultaneous operation, *e.g.* poverty, uncleanliness, overcrowding, alcoholic indulgence, and disease. The remedy is to break the circle, and according to the author "the first task of the sociologist is to extricate from the symptom-complex those dominant factors that constitute the circle, to discover the weakest link in the unending chain, and to effect a breach at the point of least resistance." The book should be of service to the social worker in assisting him to analyse social problems into their constituent factors, and the references to standard authorities which have been freely introduced will likewise be helpful.

Willing's Press Guide and Advertisers' Directory and Handbook, 1916. Pp. xii+487. (London: James Willing, Ltd.) Price 1s.

THIS concise and comprehensive index to the Press of the United Kingdom, as a sub-title describes it, this year reaches its forty-third issue. It is as useful as ever. The classified list of periodicals arranged under subjects is particularly useful. The lists of the principal Colonial and foreign journals add greatly to the value of the compilation.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Instruction in Science for Military Purposes.

IN a special war lecture on "Field Telephones," delivered before the Royal Socity of Arts on July 28, 1915, I pointed out how the services of science teachers might be utilised with advantage in training all ranks of our new armies in this important subject. Although in isolated cases work of this kind has been carried out, and highly appreciated by the military authorities, no general scheme of instruction has yet been adopted. As the urgent necessity of such instruction does not appear to be realised, a statement of the present conditions regarding facilities for training in science as applied to military purposes may be useful.

The only officers in the British Army who receive a scientific training are those belonging to the Royal Engineers and the Royal Artillery, who are attached to the regular Army. Some who obtain direct commissions in these branches receive instruction at the Ordnance College, Woolwich, at Chatham, or elsewhere; but this is by no means general. For the cavalry and infantry officers practically no facilities exist. It does not appear to be generally known that the teaching of science at Sandhurst was abandoned many years ago, and even yet has not been resumed. The result is that the greater portion of the British Army is engaged in conducting a war in which scientific knowledge is essential, without its officers having the opportunity of studying some of the most important matters relating to their duties. The circulation of pamphlets dealing with special points cannot be regarded as a substitute for proper tuition, yet it is practically the only means at present employed. It is with a view to remedying this deplorable state of things that this letter is written.

At the meeting of the Association of Public School Science Masters, held on January 5, Mr. C. L. Bryant, of Harrow, presented a scheme for the instruction in military science of boys who were receiving commissions directly from school. The subjects to be taught were suggested by the Director of Military Training in the subjoined letter:—

WAR OFFICE,
November 19, 1915.

To the SECRETARY OF THE ASSOCIATION OF PUBLIC SCHOOL SCIENCE MASTERS.

SIR,—I am directed to inform you that your offer to train future officers in various subjects is very much appreciated.

I am also requested to inform you that the War Office is not in a position, and is not likely to be in a position, to render any assistance in the provision of funds, equipment, or instructors. Subject to these restrictions, it is suggested that the training should consist of the following subjects:—

EXPLOSIVES.—The nature of various explosives in use—methods of firing charges—care in handling—detonators—fuses—methods of lighting fuses—grenades.

TELEPHONES.—Detection and mending of breaks in cables—laying of lines—remedying faults in receivers and senders—reading and sending on the buzzer.

POISON GASES.—Methods of combating same—first aid to men suffering from same.

RANGE FINDING.—Methods of taking range.

I am to enclose a manual, "Guide to Instruction in the use of Grenades," and to recommend that instruction in other subjects be from the Manual of Field Engineering, from the Training Manual, Signalling, as regards Telephones and from the Musketry Regulations as regards Range Finding.

I am to add that every possible assistance will be given to you, but that this department cannot undertake to communicate with all the Public Schools.

(Signed) F. C. HEATH-CALDWELL,
Director of Military Training.

Working on this basis, a syllabus was drawn up by Mr. J. Young, of the Royal Military Academy, Woolwich, and Mr. Bryant, to which the present writer contributed a few suggestions. This work has already commenced at Harrow and a few other schools, and it is sincerely to be hoped that every school will follow on the same lines without delay. The instruction, however, should also extend to boys about to enter Sandhurst, as such will not have an opportunity of studying the first three of the above subjects in a proper manner after leaving school. By avoiding extraneous matters, a single term's work will suffice, even in the case of beginners, to impart a mass of information of the highest practical value. It seems almost incredible that at the present time

boys who receive commissions immediately on leaving school are devoting their time to the dead languages, and enter the Army without a scrap of scientific knowledge. Any headmaster who permits this state of things to continue is an enemy both to the boys and to his country.

One difficulty to be encountered is that many science teachers may not be familiar with the matters covered by the syllabus; but by reference to the publications recommended, supplemented by a further list compiled by Mr. Bryant, they will soon acquire the necessary information. No diffidence need therefore be felt on this score; and the teacher who adopts the scheme will have the satisfaction of knowing that he is rendering the highest service to his country.

Work in public schools, however, is only one aspect of the question. There are at present in our armies hundreds of officers who stand in need of instruction, and non-commissioned officers and picked men must also be considered. It is here that our universities, colleges, and technical schools may do invaluable work. It is not possible in these cases, owing to considerations of time, to treat the subjects in the same detail as with boys at school or at Woolwich. From my own experience, however, I can confidently state that twenty hours' tuition, devoted solely to the subjects named, will give any intelligent beginner a grasp of the matters under notice, sufficient to enable him to apply his knowledge to his duties, and so to increase in competence with practical experience. Work of this character has already been conducted with success at the Finsbury Technical College, the Northampton Institute, Clerkenwell, and the Norwich Technical Institute; and if made general throughout the country an incalculable amount of good might be done. At the present juncture, the War Office could not be expected to organise such a scheme, and everything must therefore depend upon the initiative of the individual teacher. To start a class he should approach the officer commanding troops stationed in his locality with an offer to give instructions on the lines suggested by the Director of Military Training. An arrangement may be arrived at for a number of officers, N.C.O.'s, or selected men to attend at specified times; twenty being the average number who may be dealt with to advantage. The teacher must expect neither financial reward nor official recognition, nor assistance in the matter of equipment. Everything will depend upon his own voluntary efforts.

With regard to a syllabus for intensified instruction of this kind, details of apparatus, and sources of special information relating to the subjects taught, I should be pleased, subject to the consent of the editor, to supply these through the columns of NATURE, provided a demand should exist. I appeal most earnestly to all teachers of physics and chemistry, in the interests of the country, to take up this work without delay. One class will suffice to bring home to a teacher the good he can do at the present crisis. With the view of organising future work on the most effective lines I should be glad if all who commence classes would notify me, stating the subjects taught.

We are at present devoting all our attention to the quantity of men in our armies, forgetting that quality is at least equal in importance, and that science alone can prevail against science. Speaking at the recent meeting of Public School Science Masters, an officer returned from France stated that "to his own knowledge hundreds of lives had been needlessly lost through the lack of information that should be in the possession of every officer." It lies within the power of the science teachers of England to impart a portion, at any rate, of this much-needed knowledge; and it cannot be questioned that a united effort on their part, if promptly made, would be of inestimable service to their country.

CHAS. R. DARLING.
City and Guilds Technical College,
Finsbury, E.C.

A Relation between Atomic Weights and Radio-active Constants.

CONSIDER the group of chemically identical (isotopic) elements :—

		Approximate atomic weight		Range of α particles
Radium A	...	$\omega=218$	...	$a=4\cdot50$ cm.
Thorium A	...	216	...	5·40
Actinium A	...	214	...	6·16
Radium C′	...	214	...	6·57
Thorium C′	...	212	...	8·16
Polonium (Ra. F)		210	...	3·58

If $\log \omega$ be plotted against $\log a$ the points will be found to lie along a straight line :—

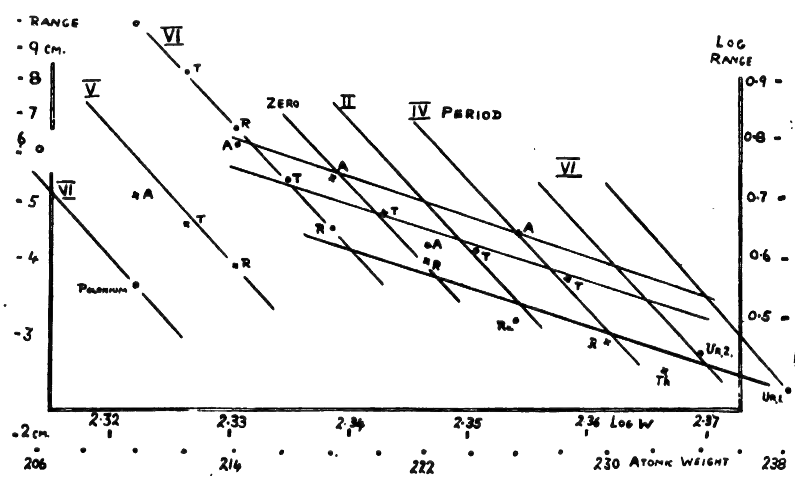

FIG. 1.—The radium elements are all marked R. The thorium elements are all marked T. The actinium elements are all marked A.

The two circles are the exterpolated points referred to in the text.

Fig. 1 shows log α for all the known α-ray elements, as follows :—

Dots.	Period VI.	Uranium 1 (atomic weight 238). Uranium 2 (234).
Crosses.	Period IV.	Thorium (232). Actinium (230). Radio Thorium (228). Radio Actinium (226).
Dots.	Period II.	Radium (226). Thorium X (224). Actinium X (222).
Crosses.	Zero Period.	Emanations from Radium (222). Thorium (220). Actinium (218).
Dots.	Period VIB	Radium A (218). Thorium A (216). Actinium A (214). Radium C′ (214). Thorium C′ (212). [Actinium C′ 210 unknown.]
Crosses.	Period VB	Radium C (214). Thorium C (212). Actinium C (210).
Dots.	Period VIB	Polonium=Radium F (210). [Possible actinium element. 206.]

Though some of the lines are somewhat straggling, still each group of isotopes gives a line, and the lines are approximately parallel and equally spaced. The range is thus universally proportional to about the 21st power of ω in each case. Moreover, the groups follow one another in a rational order, Period No.

VI. of the periodic table being followed by Nos. IV., II., and zero, and then by Nos. VIB and VB.

In period VIB polonium appears to be the starting-point of a new line, the thorium and actinium elements of which are still unknown. No further products of Act C are known corresponding to the polonium branch of the radium series, and Act C′, if it existed, should, by Fig. 1, have the record range of about 10 cm. About 0·17 per cent. of the Act C rays are, however, said to have a range of 6·1 cm., which would be fairly suitable to an element of at. wt. 206 on a line drawn parallel to the others on Fig. 1 starting from polonium.[1]

It is specially noticeable that to make the actinium points lie on the same lines as the corresponding radium and thorium elements, its atomic weight must be reckoned in every case from actinium = 222 instead of 226. This means that the actinium series branches off from the uranium stock at Ur(2) instead of at Ur(1). Either scheme is equally allowable, but no evidence has hitherto been brought forward to decide between them.

Another set of lines can be drawn on Fig. 1, one through the actinium points, one through the thorium points, and the lowest through the uranium elements. The latter are, however, very scattered, and include thorium itself amongst them. The lines do not go beyond the "A" elements.

These relationships were detected from noticing first the evident family resemblance between the γ rays in the isotopic groups. For example, in period IVB we have:—

	"K" Series		"L" Series		Soft Rays		β Rays
Ra B	0·19	...	14·7	...	85	...	75
Th B	0·13	...	11·8	...	59	...	110
Act B	0·17	...	11·5	...	44	...	—
Ra D	0·36	...	16·7	...	—	...	130
Lead	—	...	17·4[2]	...	—	...	—

Among the β rays something of the sort is noticeable, μ generally falling with increasing atomic weight, but for the very soft (β) rays μ is directly proportional to the 33rd power of ω.

F. GILBERT CARRUTHERS.

December 14, 1915.

The Naming of Earthquakes.

AN earthquake is usually distinguished by the name of the town, province, or country, near or within which it originates, and by its date—the double nomenclature serving to determine its position in space and time. With regard to the latter element, absolute uniformity prevails. The year, month, and day are always given, except for great and long-past earthquakes, for which the year only is sufficient. My object in this letter is to suggest the desirability of similar uniformity in the use of the place-name.

Nearly all seismologists have a different standard for earthquakes of their own country and for those of distant lands. An Italian, for instance, will speak of a Benevento earthquake or a Neapolitan earthquake, but also of an Indian earthquake, or even of an Asiatic or Pacific Ocean earthquake. Temporarily, no doubt, the use of the country's name is convenient; but, as every country contains many seismic regions, its continuance is undesirable. Even in the same country various methods prevail. Thus, Indian seismologists describe a Bengal, a Kashmir, and a Kangra earthquake.

[1] With such a short range of ω it is not easy to distinguish log ω from α. For convenience, ω and α are both shown on this scale, as well as log ω and log α.

[2] The figure for lead is for the characteristic X-ray.

These variations in nomenclature are clearly inconvenient. On the one hand, different names are given to the same earthquake. Thus, one may be called the East Anglian, the Essex, or the Colchester earthquake; another the Indian, the Assam, or the Calcutta earthquake. On the other hand, the same name is applied to earthquakes with different origins. In the writings of Italian seismologists, the terms "Calabrian earthquake" is of frequent occurrence. As a family or generic name it is useful, but it groups together earthquakes which belong, as Dr. M. Baratta has shown, to eleven different seismic zones. Thus the six great earthquakes of the Calabrian series of 1783 affected in succession the Palmi, Scilla, Monteleone, Messina-Scilla, Monteleone, and Girifalco zones, and might with advantage have been designated by their names. Again, the earthquake of 1638 occurred in the Nicastro zone, that of 1659 in the Monteleone zone, that of 1836 in the Bisagnano zone, that of 1854 in the Cosenza zone, that of 1894 in the Palmi zone, and that of 1907 in the Gerace zone. These earthquakes, in like manner, might be named after the corresponding zones. To this rule, however, there must be occasional exceptions. For instance, the earthquake of 1905 originated in five zones, and it would be out of the question to call it the Palmi-Monteleone-Nicastro-Cosenza-Bisagnano earthquake of 1905. When the epicentre covers so large a part of a province, it establishes a claim for this earthquake to be known as the Calabrian earthquake of 1905.

While adhering so far as possible to prevalent customs in naming earthquakes, and especially adopting those assigned to them by their principal investigators, I would suggest that the choice of names should be determined by the following principles:—

(1) Old and obsolete names of districts, such as East Anglian, should be avoided, as conveying little or no impression of locality to foreign seismologists.

(2) Names of valleys, hills, seas, lakes, or other physical features should not as a rule be used, with perhaps occasional exceptions, such as Exmoor or Ochil, when there are no prominent towns or villages in the neighbourhood of the epicentre.

(3) Names of islands as geographical terms may, however, be usefully employed when the islands are small (as Zante), or perhaps large and not well known (as Formosa), but not when they are large and well known (as Jamaica). Thus, it would be more convenient to speak of the Ischian than of the Casamicciola earthquake, and of the Kingston and Port Royal than of the Jamaica earthquakes.

(4) Whenever possible, the name of a prominent or well-known town near the epicentre should be applied. The term Charleston earthquake, for instance, is more descriptive than the Woodstock-Rantowles earthquake, though these places are much closer to the double epicentre.

(5) If there is no large town near the epicentre, the name of a small town or village (with that of the province or county added in brackets) may be used with advantage, such as the Viggianello (Basilicata) earthquake of 1894, or the Strontian (Inverness-shire) earthquake of 1902.

(6) When the epicentral area is of considerable size, the name of a single town ceases to convey the desired impression, and the names of many places would be cumbrous. Thus, an earthquake with an epicentral area at least 290 miles in length deserves the name of Californian rather than that of San Francisco. An earthquake which originates in five seismic zones, which are often disturbed separately, is, as already mentioned, suitably described as a Calabrian earthquake.

CHARLES DAVISON.

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ORIGIN OF GREEK TRAGEDY.[1]

THE object of this, Prof. Ridgeway's latest contribution to the early history of the stage, is to expand and reinforce with additional evidence the thesis which he formulated in his "Origin of Tragedy," published in 1910. The doctrine of this earlier work asserted that the drama of the Greeks was not, as had hitherto been supposed, derived from the cult of Dionysus, but was based on the worship of the dead, and reflects the primal tragedy of human life. In order to secure this position it was necessary to controvert the theories of two allied schools of interpretation of primitive religion, and, as often happens, the constructive part of the work is inferior in interest to the polemical, when the attack falls into the hands of a critic so acute, learned, and witty as the writer.

In dealing with the school represented by "The Golden Bough," Prof. Ridgeway begins by stating that "it is with extreme reluctance and with genuine sorrow that I have found myself compelled to differ on this fundamental question from one of my oldest and best friends." The gulf fixed between Sir James Frazer and himself is, indeed, great. The former holds that vegetation spirits and the phenomena embraced under the term Totemism are primary and absolutely independent of the belief in the existence of the soul of man after the death of the body. Prof. Ridgeway, on the other hand, asserts that vegetation spirits and Totemic beliefs are merely secondary phenomena, all depending on the primary belief of mankind in the continued existence of the soul after the death of its carnal covering. He rejects the famous explanation of the Nemi story, which he holds to be largely based on suppositions and suggestions. The priest of the Arician grove is not the personification of the oak, which is not the sacred tree at Olympia, the centre of the worship of Pan-Hellenic Zeus, but derives its sanctity from its association with a death cult, the worship of Egeria suggesting that honour was paid to the burial place of the Egerii.

[1] "The Dramas and Dramatic Dances of Non-European Races in special reference to the Origin of Greek Tragedy." By Prof. W. Ridgeway. Pp. xv+448. (Cambridge: At the University Press, 1915.) Price 15s. net.

The attempt of Sir James Frazer to account for dramatic performances by the dramatisation of the seasons is also necessarily rejected; magic is not antecedent to religion; and with the abandonment of the vegetation hypothesis goes the doctrine of Dr. Farnell that dramatic performances of this type are primitive, and antecedent to dramas based on human life. The criticism of the school represented by Miss J. E. Harrison and her fellow-workers, Prof. G. G. Murray and Mr. F. M. Cornford, who postulate the Eniautos Daimon and heroes as a projection from certain *choses sacrées*, is even more drastic. An important part of the material adduced to support the supremacy of ancestor worship as the basis of primitive cult and belief comes from India, and

FIG. 1.—Scene in a Rama play: Ram Chandra and Lakshmana. From "The Dramas and Dramatic Dances of Non-European Races."

the euhemeristic views of the late Sir A. Lyall, which regard most of the gods of Hinduism as deified men, are fully accepted. The *mana* of Dr. Marett resolves itself into a development from relic worship, and his dogma that religion develops from the undifferentiated to the differentiated is criticised on the ground of the complexity of savage society, and in particular its highly developed system of relationship.

It would be premature to discuss these positions, which are still the subject of acute controversy, and the forces now on the defensive may be in a position to make a successful counter-attack. This much may be said: while Prof. Ridgeway has doubtless succeeded in proving that the cult of the dead has exercised potent influence on the development of drama—indeed, his leading opponent, Prof. Murray, admits that "it can be shown that every extant tragedy contains somewhere towards the end the celebration of a *tabu* tomb"—many will hesitate to refer such a complex as dance and drama throughout the world to a single concept; and, to take India alone, Sir A. Lyall's view, which excludes the cult of spirits other than human, leaves unexplained the devotion to Siva, who was in origin a storm god, later developed into a deity of fertility, or to the still potent spirits of mountain, river, or spring.

FIG. 2.— The Buffoon (*Tchou*). From "The Dramas and Dramatic Dances of Non-European Races."

We have almost exhausted our space in discussing the important problems raised in the introductory chapter, in which the learning, acumen, and wit of the author are conspicuous. The material on dance and drama among barbaric and savage races is of the highest value, and must be studied by all future historians of the stage. The facts from India, due to help received from Sir John Marshall and the staff of the Archæological Survey, are of special interest, and the fine collection of photographs taken for this work is admirable. Two of the illustrations are here given, by the courtesy of the publishers. When we are told that the Shiah form of Islam is dominant in India, it may be pointed out that though this sect is more active and fanatical than that of its rivals, the Sunnis, the latter holds a decided numerical superiority. It is to be regretted that the proofs of the chapter on Hindustan were not read by a competent Oriental scholar, who would have been able to detect some irritating perversions of names which detract from the scientific accuracy of the work.

THE METRIC SYSTEM AND DECIMAL COINAGE.

THERE are probably few readers of NATURE who do not realise that what is being referred to in the Press as "The War after the War" is nothing more than a tardy appreciation of the "war before the war" which Germany has been waging against England for a quarter to half a century in the applications of science to commerce. It has been stated over and over again that German firms have been ousting British trade in many countries by issuing price lists containing quotations in the metric system of weights and measures. A further element of success has been that the enterprising Germans have in many cases told prospective purchasers the exact amount of money in their own currency which they would have to pay in order to have the goods delivered at their house, free of carriage, customs dues, or all other charges.

Now scientific men have been preaching the adoption of the metric system for years. The advantages which this country would gain by discarding British weights and measures, and using those which have now become international, are well known to every thinking man. In these circumstances it must be regarded as regrettable that the *Electrical Review*, in a series of articles entitled "Decimal Coinage and the Metric System" (October 15 to November 26), has associated these undoubted claims for standardisation of units with the advocacy of a change of monetary system which nobody understands, and which does not appear calculated to advance the cause of international uniformity.

The editor of the journal in question circulated among business firms about 450 copies of a letter, to which more than 120 replies were received. The following questions were asked of the recipients of the letter:—

1. Do you employ the metric system in your correspondence with foreign clients?
2. Are your products
   (a) described in your catalogues in terms of metric weights and measures?
   (b) priced in terms of foreign coinage?
3. Do you employ the metric system in your workshops?
4. Are you in favour of the adoption in this country
   (a) of decimal coinage?
   (b) of metric weights and measures?
5. May we quote your name in referring to your replies in the *Electrical Review*?

The result has been a very thorough discussion of the advantages of the metric system, and the absence of any substantial evidence regarding the monetary question. Many firms are actually using metric units; in electrical, physical, and chemical work they have become universally recognised, and in cases where they are not exclusively adopted they are at least used in foreign trade. On the other hand, few firms are able to give quotations in foreign currency, owing to the varieties of foreign coinage and the fluctuations of the rate of exchange. Where manufacturers have expressed themselves favourably to decimal coinage their replies strike us as not being based on any substantial grounds.

In examining this aspect of the subject the questions which naturally arise are:—(1) What is meant by decimal coinage? (2) What countries have adopted it? (3) What is the system it is proposed to adopt here?

Now the decimal system of weights and measures which is in international use is based on a distinctive and unique nomenclature for tens, hundreds, thousands, and the corresponding submultiples of the fundamental unit, whether it be a unit of length, capacity, or weight. By a process of natural selection those multiples and submultiples have been retained which have been found most useful; for example, millimetres, centimetres, metres, and kilometres, to the exclusion of other derived units. But no country in the world has adopted a decimal coinage based on this nomenclature. Instead of this we have a perfect chaos of centesimal systems, each based on the subdivision of a fundamental unit into a hundred "cents." In most cases, sums of money amounting to millions of pounds are expressed in terms of a unit no larger than a shilling, while sums less than a shilling are expressed in tenths of a penny, although coins of less than five-tenths are rarely used. In some cases $\frac{2\frac{1}{2}}{100}$ of the larger unit is commonly used in preference to the $\frac{1}{100}$.

The plea for a decimal coinage must therefore either be an advocacy, not of a decimal system, but of a centesimal system similar to one actually in use, or it must represent a demand for something new and different.

Now the disadvantages of uniformity will be evident to anyone who travels in one of the countries of the so-called Latin Union, such as France, Switzerland, Italy. It is often quite impossible to obtain change for a sovereign in the current coin of the realm. Instead the traveller receives a collection of coins of a number of different countries, some of them good, others bad. The only countries in which bad money can never circulate are those, such as Germany and Austria, which have distinct monetary units. If England were to adopt the franc and centime, England would soon be flooded with foreign money. The difficulty of deciding, by means of diagrams, whether a particular coin is good or bad is at least equal to the difficulty of reducing shillings to pence, and most inhabitants of the countries in question have accumulations of bad money that they are only too glad to pass off on an uninitiated Englishman.

If, however, the system is to be different from those of other countries, it is difficult to see how it can facilitate foreign commerce. The exchange value of an English sovereign is well known all over the world, and quotations in pounds are fully understood. The only difficulty may arise among foreign clients with the twelve pence in the shilling. But in foreign trade pence practically never enter into the calculations, and all that the manufacturers need do is to give their quotations in decimals of a pound, which they can easily do.

It is in the last of the series of articles that the contributor of the *Electrical Review* gives himself away. After obtaining overwhelming evidence of the advantages of the metric system, he proposes that the coinage should be changed first, and that the remaining changes should follow within a time-limit of one twelvemonth. It would appear that the proposed coinage should leave the pound and the shilling intact, and should depreciate the value of the penny by about 4 per cent.

We need not have any serious apprehensions that Parliament would ever consent to a proposal which would rob the working-man of a fraction of the value of his penny while leaving the income-tax payer unmulcted. It is, however, fairly evident that if such a scheme were adopted penny articles would not be sold for less than a penny farthing, and we should thus approximate to the system of marks and *pfennige* of Germany.

The writer of the present article happened to be travelling in Austria a little while after the change from gulden and kreuzer to kronen and heller, and although this alteration involved nothing more than doubling the figures, the confusion was very great and the change took a long time to effect.

It is quite clear that any attempt of this kind introduced during the present universal upheaval would lead to a state of chaos in our international trade which would induce our foreign clients to transfer their business to Germany, or to some neutral country with the coinage of which they had become familiar.

In conclusion, whether the attempt to introduce

decimal coinage be desirable or undesirable, its association with a movement for adopting the metric system can only have the effect of retarding a change for which the time is ripe, and which is necessary in order that Great Britain may hold her own in the world of international commerce.

G. H. B.

NOTES.

The recent circular addressed to the dealers in platinum by the Director of Materials in the Ministry of Munitions requiring them to make a return of the whole of the stock of this metal, its ores and residues, on their premises, and forbidding any trading without a permit under a heavy penalty, will cause no surprise to those scientific men who are cognisant of the situation. Indeed, it is to be regretted that this step has not been taken before. It is most unfortunate that this rare, and for many purposes indispensable, metal has been allowed to be used for jewelry and purely ornamental purposes. Either silver or gold is much better adapted to the production of attractive ornaments and is more beautiful than the greyish-white of platinum, while, of course, neither has the high melting point, electrical resistance, and chemical refractory qualities which make platinum so valuable a metal both in science and in the arts. The normal annual world's output of this metal is about 300,000 troy ounces. This figure dropped in 1914 to 250,000 ounces in consequence of the outbreak of war. Russia produces 95 per cent. of the world's total, chiefly from the Ural placers. The crude platinum contains from 70 to 90 per cent. of this metal, but it is invariably alloyed with iron in considerable proportions and with varying amounts of the other metals of the platinum group. Colombia produces about 10,000 ounces, while the total output of other countries does not exceed 2000 ounces. It is obtained in the United States Mint in the electrolytic refining of gold and silver, but only in amounts of about 200 ounces per annum. A small amount is also recovered from the mud resulting from the electrolytic refining of copper. Considerable interest was aroused by the recent announcement that platinum had been discovered in the Lower Rhine region of Germany. No statements as to its possible commercial exploitation have as yet been forthcoming.

Since the outbreak of war, the research institutes and stations aided by the Board of Agriculture under the Development Act scheme have been fulfilling useful functions. The new conditions have given rise to many new problems, chiefly in regard to the use of new feeding stuffs and the supply of artificial manures. In relation to the former, the blockade of Germany's imports has led to the appearance on the home markets of a number of oil-seed residues, such as palm-nut kernel, coconut, etc., in regard to the use of which as feeding stuffs little precise information was available; again, the scarcity and dearness of some of the other better known materials have necessitated the use of substitutes, and it has become important to supply agriculturists with advice on the making up of rations containing unfamiliar mixtures of ingredients. The Institute of Animal Nutrition at Cambridge has given valuable aid in this direction, and the monthly notes which it contributes to the Journal of the Board of Agriculture contain information which has been much appreciated by farmers.

The utilisation of peat, whether as a source of power, for use in the manufacture of explosives, or as the basis of a manure, is attracting much attention at present, and the subject is naturally one in which the Rothamsted Experimental Station is in a position to undertake useful work. At the request of the Board of Agriculture, the station has recently undertaken to make a complete investigation of the claims made in regard to Prof. Bottomley's bacterised peat or "humogen," the nature and properties of which were described in Nature of December 9, 1915 (p. 399). As they have been stated in the daily Press, these claims appear to be threefold: first, that the substance contains an accessory food substance; secondly, that it supplies soluble humus; and, thirdly, that its nitrogen content is higher than that of most organic manures. The first claim—the presence of an accessory food substance—is the one that will attract most attention, for if it can be substantiated it will not only constitute a distinct scientific advance, but will make the economic problems involved much simpler. "Humus," after all, is the cheapest manure, and it is not likely that for ordinary agricultural crops any manufactured product will be able to compete with such a cheap source as the farm manure-heap. The investigation at Rothamsted will include an examination of the processes by which humogen is manufactured, as well as trials on a field scale under carefully controlled conditions.

Mr. Tennant stated in the House of Commons a few days ago that from the beginning of hostilities to November last, 1365 cases of enteric (typhoid) fever were reported as having occurred among British troops in France and Belgium. Of these, 1150 had been diagnosed after bacteriological examination. In 579 cases where there had been inoculation there were 35 deaths, and in 571 cases where there had been no inoculation there were 115 deaths. We hope that Mr. Tennant's statement will put a stop to the last trace of opposition to the protective treatment against typhoid fever. We do not say that the method is perfect; but we do say that it protects our soldiers from dying of typhoid fever. The figures given by Mr. Tennant are absolutely final; the method, in years to come, may be improved; but the good which it has achieved is past all possibility of sane doubt. Happily, the opposition never came to much, and now is coming to an end. It has had one good effect on the public mind: it has helped to destroy the influence of the "anti-vivisectionists" and the "anti-vaccinationists." These two bodies, never far apart, made common cause against the work of protecting our soldiers against the horror of death from typhoid fever. Among the "anti" assertions, we may note the statement that typhoid and paratyphoid are so like each other that the figures for typhoid are worthless. This assertion is untrue. Even if we add the paratyphoid cases to the typhoid

cases, and put them all together, the results of the protective treatment are still above the least shadow of doubt. If any reader wishes to have leaflets for distribution, giving a simple account of the treatment, he should apply to the hon. secretary of the Research Defence Society, 21 Ladbroke Square, London, W.

A LUNCHEON was given to Sir Edward Carson, on January 12 at the Savoy Hotel, by the Institute of Industry. In his address Sir Edward Carson referred to a number of questions which would have to be answered after the war, and urged the need for concentration of effort. He said there should be no essential article, either for the arts of peace or for the arts of war, upon which we could not within the Empire lay our hands. He never could understand, he continued, why the question as to what was best for our industry, commerce, and finance should be any concern of the party politician. It was a pure business question, and it was there that the Institute of Industry came in. It was for them, by strengthening it and working out these problems, to make themselves felt in the settlement of these great matters. A discussion was opened by Mr. J. Taylor Peddie, chairman of the institute, by an address on the new national business policy. He explained that among the objects of the institute it was intended to secure the establishment of a Ministry of Industry, to develop national and Imperial industries, and to stimulate and encourage the standardisation of our educational system. The following resolution was adopted unanimously:—"That this meeting of manufacturers and other representative men closely connected with all phases of industrial activity in the British Empire, fully endorses and approves of the objects and policy of the Institute of Industry, and recommends all persons or companies interested in the industrial life of the British Empire to support the institute by becoming members."

MR. F. M. LLOYD, Besselsleigh, Douro Road, Cheltenham, has issued a circular in which he urges the establishment of a Board of Investigation and Experiment, not only to consider suggestions, but also to carry out experiments upon them, with the view of bringing any that are of practical utility before the notice of military or naval departments, or otherwise promoting their development for national purposes. The weakness at present results from want of organisation. It cannot be expected that the officials of all the great Government departments are able to judge of the practicability or value of the scientific suggestions or inventions placed before them; so it often happens that ideas are pigeon-holed or correspondents are advised to apply to other officers or departments. Mr. Lloyd gives several instances of this repressive policy; and he asks that the whole question of invention and experiment should be placed on a sounder basis, and that greater facilities should be given to the inventor. A new department had been established in France to co-ordinate the work of men of science and engineers for the service of the country, to examine what proposals are feasible, and assist in the realisation of promising ideas. A like centralisation seems to be needed here, so that suggestions shall not be passed over because they have been sent to a wrong department, and that promising ideas may first be tested by scientific experiments and be put into practical application if successful. We have advisory boards of invention and research connected with the Admiralty, Ministry of Munitions, the Board of Education, and other Government departments, but Mr. Lloyd emphasises the need for a new department which will co-ordinate the whole service for the promotion of science and invention. He invites all who are willing to help to attain this end to communicate with him.

SEVERAL letters on the relation between science and industry, with particular reference to the decline of our dye-stuff industry, appear in the *Observer* of January 16 as comments upon an article contributed by Prof. H. E. Armstrong to the issue of our contemporary a week before. On one side we are told that the old patent laws, which allowed the Germans to make our dyes, but prevented us from making theirs, was chiefly responsible for the loss of the dye industry; and on the other that the decline was due to the neglect of science by our manufacturers and commercial men. As to the employment of chemists, Mr. W. G. Black asserts that "the British manufacturer is alive both to their value and limitations," and the editor of the *Dyer and Calico Printer* that "the British colour-making trade generally has never been without good business men and clever research chemists." Mr. J. W. Green, registrar of the Institution of Chemical Technologists, supplies the answer to these views in a statement of the training and position of the technical chemist in this country. The college and the factory are admittedly not in sufficiently close touch, but the relationship between them will become much stronger when the prospects of a properly trained industrial chemist are improved. Mr. Green says that one of the largest concerns of its kind pays its chemists thirty-five shillings a week each as a maximum salary, while a skilled labourer in the same firm can earn five or ten pounds a week, and his wages never drop to the level of the chemist. This is typical of the value which our manufacturers usually place upon the work of the chemist, and it is not surprising that such an attitude has had its effect on academic circles. 'What is urgently wanted is a definite training and status for the profession of chemistry, and efficient co-operation between the technical chemist, the chemical manufacturer, and the Government.

THE Guthrie lecture of the Physical Society will be delivered at the Imperial College of Science on Friday, January 28, by Mr. W. B. Hardy, upon the subject of "Some Problems of Living Matter."

MAJOR F. W. MOTT, F.R.S., will deliver the Lettsomian Lectures to the Medical Society of London on February 7 and 21 and March 6, taking as his subject the effects of high explosives on the central nervous system.

IT is announced in the *Daily Mail* of January 18 that Dr. Aylmer May, principal medical officer of Northern Rhodesia, has been selected by the War Office to undertake research work on the western front in connection with wound infection.

An exhibition of photographs demonstrating the application of photography to marine biology, by Mr. F. Martin-Duncan, is open free to the public on presentation of visiting card at the Royal Photographic Society of Great Britain, 35 Russell Square, W.C., and will remain open until Saturday, February 12.

Owing to the generosity of Mr. J. S. Corder, a member of the committee of the Ipswich Museum, the whole of the remainder of the collection of flint implements of the late Lieut.-Col. Underwood has now passed into the possession of this institution. The Ipswich Museum had already purchased all the Dovercourt and local specimens belonging to Col. Underwood, and this new acquisition will add greatly to the extent and value of the prehistoric stone implements displayed in the building. The arrangement of the specimens has been placed in the hands of the curator, Mr. J. Reid Moir.

The railways of Asia Minor and Syria attract much attention now in view of their relation to the war in the Near East. A useful paper on the subject accompanied by a large folding map appears in the Bulletin of the American Geographical Society for December, 1915 (vol. xlvii., No. 12). The nationality of the dominant control in each line is shown by distinctive colouring on the map. The German railway through Asia Minor from Scutari to Aleppo is complete except for the Taurus tunnel. It has coastal links by a French railway to Smyrna and Söke, and by German lines to Mersina and Alexandretta. From Aleppo it runs to Harran, but later reports announce its completion to Ras-el-ain. The only part of the Bagdad railway in working order is between Samarra and Bagdad. When the Taurus tunnel is completed there will be through railway communication from Scutari *viâ* Aleppo to Damascus, and thence by Turkish lines to Medina, or to Gaza, near the frontier of Egypt. Details are wanting of the reported line, now being built, from the Syrian lines into Egyptian territory. The Medina line is to be extended to Mecca and Jedda. The whole cost of this line from Damascus southward is said to have been met by offerings of faithful Mohammedans.

An earthquake of some importance for this country was felt in the Midlands on January 14, at 7.29 p.m., chiefly in Staffordshire, though the disturbed area also included the greater part of the adjoining counties of Cheshire, Shropshire, Warwickshire, and Derbyshire. From the reports so far collected, it appears that the shock was felt from the neighbourhood of Manchester on the north to Hartlebury and Henley-in-Arden on the south, and from Leicester on the east to Malpas on the west. The disturbed area must therefore be at least 85 miles long from north-west to south-east, and 65 miles wide, and containing about 4340 square miles. The centre of the area is in the neighbourhood of Stafford, a district which has not been the seat of a strong earthquake for many years. The earthquake was probably a twin earthquake, for the shock consisted of two series of vibrations throughout a large part of the disturbed area. Mr. J. J. Shaw states that the earthquake was recorded by his seismograph at West Bromwich. The movement began at 7.29 p.m. For the first two minutes the vibrations were very rapid and ceased to be perceptible about 7.40.

A great earthquake was recorded at Sydney on January 14, the seismograph at the River View College being disturbed so violently that the needle left the recording sheet. It is estimated that the epicentre lay about 500 miles to the north-west of Port Darwin. On the same day a disastrous earthquake is reported from New Guinea, especially at Raboul, the seat of the Government when that portion of the island was under German control. No times are as yet known for either earthquake, but it is evident that the reports can scarcely refer to the same shock unless there is some error (say, north-west for north-east) in the estimated position of the epicentre. It is worthy of notice that a large part of New Guinea is almost aseismic, though earthquakes are not infrequent at Dorei, and near the eastern extremity of the island.

Mr. George Tucker, chairman of the *Electrician* Printing and Publishing Co., Ltd., died last Saturday after a long illness. He was sixty-four years of age, and had been connected with the *Electrician* since 1878. Starting as a compositor, he won his way to the supreme control of the *Electrician* Co. by sheer hard work and business ability. In 1883 he was appointed overseer of the printing department, and in 1887 was made publisher and business manager. It was, we believe, largely due to his representations that the proprietors of the *Electrician* decided on the policy of publishing technical books and advanced text-books on electrical subjects, the earlier volumes of which particularly did much to advance the accurate study of applied electricity.

We notice with regret the announcement in the *Times* of the death, on January 16, of Dr. H. Williams, medical officer of the Port of London. Dr. Williams was born in Weymouth in 1862, and received his medical education at St. Bartholomew's Hospital. His appointment as medical officer of health for the Port of London was made in 1901. He took a deep interest in all that concerned the welfare of the Port, and it is due to his scientific enthusiasm that the work there has been of so progressive a character. He was a vigilant detective of disease, and he spared no pains to shut the door in the face of epidemic conditions.

We see in the *Chemist and Druggist* the announcement that Dr. Georg Grübler died last November in Jena. In his early days he was a pharmacist, but he soon became an earnest student of physiological chemistry, and in 1880 he founded a laboratory at Leipzig, where he devoted himself to physiological and bacteriological research. He became well known for his work in connection with the proteins, and after he retired to Dresden in 1897 became interested in the subject of enzymes, and especially in their preparation in as pure a form as possible. His so-called "pure" pepsin, trypsin, and steapsin are well-known preparations. He is, however, most widely known for his bacteriological stains, which have a world-wide reputation.

THE war has just inflicted another heavy loss upon King's College, London, in the death of Capt. Matthew Thomas, 7th Loyal Lancashire Regiment, who was shot in France on December 31, 1915. Capt. Thomas was a fellow-student with Thomas Wright (whose death we reported last May). He passed in 1909 from the Grammar School, Wigan, to the training department at King's College. While there he obtained first-class honours in physics at the B.Sc. examination in 1912. He stayed on for two more years, winning the Layton Research Scholarship and doing tutorial and research work under Prof. Barkla. Soon after Prof. Barkla took up his present post in the University of Edinburgh, Mr. Thomas obtained a junior appointment there under him, but he was prevented by the outbreak of war from entering upon what would assuredly have been a very valuable career in science. He was given a commission in August, 1914, and obtained his company eleven months later. He fell whilst warning his men to take cover from a dangerous sniper, to whom, alas! he himself became a victim.

THE problem of Cape horse-sickness is discussed by Sir Arnold Theiler in the *South African Journal of Science* for October, 1915 (Vol. xii., No. 3). The microbe of this disease is not known, as it is a "filter-passer"; it is probably conveyed by a winged insect, though this also is unknown, for horses stalled in stables made insect-proof are protected from the disease. There is a definite horse-sickness season, so that the virus must be maintained in some "reservoir" in the intervals, but so far the species responsible has not been discovered. No form of treatment is of much avail, and for the time being the eradication of horse-sickness lies in the protection of animals against infection.

IN the December issue of *Man* Dr. W. L. Hildburgh describes, with illustrations, a large collection of amulets from Cairo and Japan. Of the former some are dependent for their supposed virtues primarily on qualities inherent in their materials, though in some cases these qualities have been enhanced by art. Silver, which is regarded as a protection against evil supernatural beings, is largely used in their construction, and the mounting is generally such as to give the amulet the form of a pendant. Among the Japanese examples that of the *manjinai*, intended to attract the love of a person, is common. It often takes the shape of a dog, supposed to act as an agent to cause the arrival of a person desired. The magical intention is prominent in this series of examples, as in the case of a special form, prepared with the eyes left blank, of the tumbling toy representing the legless ascetic Daruma. To secure the attainment of what is desired the image is promised the gift of one or both eyes if the desired result be secured.

OF the parasitic hymenoptera known as "Chalcids" more than four thousand species have been described. Several hundred new Australian species have now been added to this list by Mr. A. A. Girault. These are fully described in vol. iv. of the Memoirs of the Queensland Museum. The labour expended in preparing this volume must have been enormous. But whether the author was justified in creating such an array of new species from the evidence of single specimens time alone will show. Only in a few very exceptional cases, it would seem, was it possible to give the name of the hosts of such parasites. As a rule the author can do no more than describe the habitat as "Gordonvale, Queensland." In his introduction he comments with enthusiasm on the remarkable diversity in structure and coloration which these minute flies exhibit. The family, he remarks, "is open to philosophical treatment of the highest order."

To discover whether the various objects carried about on the spines of the purple-tipped sea-urchin (*Echinus miliaris*) were accidentally picked up or deliberately placed there has recently formed the subject of a series of experiments by Mr. H. N. Milligan. He gives the results of his inquiry in the *Zoologist* for December. While usually stones, sea-weed, or shells are carried, tube-worms, hydroids, periwinkles, or tunicates, as chance may determine, are also used, apparently for the purposes of disguise and protection from enemies. That such objects are borne with a purpose, and not as a result of accident, is shown by the fact that when all foreign bodies are removed from the spines of urchins living in an aquarium, they will invariably be speedily replaced as soon as their loss is perceived, the tube-feet being used to perform this office. Young individuals were more assiduous in this regard than adults, but in all cases particular care was taken to conceal the anus, which is apparently a very vulnerable spot. In the same number Mr. J. M. Dewar concludes his noteworthy observations on the relation of the oyster-catcher to its natural environment. The presence of a large human population in the vicinity of its haunts has an important bearing on the permanence of its breeding stations. If these are to be maintained they must afford a safe temporary refuge at no great distance off, when the actual breeding area is invaded.

MESSRS. SHERRATT AND HUGHES, Manchester, have published a summary, written by Mr. J. Arthur Hutton, of the evidence given at a Board of Agriculture and Fisheries inquiry into the salmon fisheries of the river Wye. There had been a marked depreciation of the river during the period 1892 to 1900, and various scientific investigations, by Mr. Hutton and others, had been carried out. From 1902 to 1904 netting was prohibited in the Wye, and this restriction was followed by a notable improvement in the fishery. A further restriction for the period of rod-fishing was then suggested, and this proposal was the subject of the inquiry. The pamphlet contains a summary of the statistics collected by Mr. Hutton.

THE presence of manganese in plants has been repeatedly observed, but it has hitherto been considered to be an accidental constituent. Mr. W. P. Headden, of Colorado (*Journ. Agric. Research*, November 22, 1915), adduces evidence to show that this is probably an incorrect view, and that its constant presence in certain cereals indicates it is not an unessential constituent. It occurs in wheat

wherever grown, irrespective of soil and climate, in about the same proportion as iron. If Mr. Headden's view is correct, the discovery opens up a new field of research in order to determine the physiological function of manganese in vegetable metabolism.

AN account of an exceptionally heavy rainfall during a thunderstorm at Malta has been received from Dr. Thos. Algius, the officer in charge of the meteorological observatory attached to the university. The thunderstorm passed over the island during the early hours of November 22 of last year, and the amount of rain registered is said to be nearly equal to that known as the St. Nicholas day outburst some forty years ago. The barometer fell nearly two-tenths of an inch prior to the downpour, and the direction of the wind was south-easterly, increasing in velocity to 25 miles an hour and to nearly 30 miles an hour in gusts. The air temperature dropped suddenly from 65° to 58°. The rainfall registered at the observatory was 7·24 in., but 11·57 in. fell during the cloudburst on October 16, 1913. Rainfall returns supplied by the elementary schools well scattered over the Maltese islands have provided data for mapping the fall, which ranged from 8·60 in. to a much more modest measurement.

THE mean salinity and surface temperature of the North Atlantic and English Channel for June, July, and August, 1915, are shown in a series of charts on the Monthly Meteorological Chart of the North Atlantic for January, 1916. Charts are also given showing the average salinity and surface temperatures of the English Channel for the same months during the last eleven years. The charts were prepared by Dr. E. C. Jee, from British and Dutch data. They all show a persistent decrease in salinity from the mouth of the Channel eastward to the Straits of Dover, but they show no marked deviation among the three months. In addition to the usual features of the monthly issue, the January number contains also a table giving the percentage of days with fog at lighthouses on the Newfoundland coast, in most months for an average of ten years.

THE papers on the heating of electric wires and cables by Messrs. Melsom and Booth, which are reproduced in vol. xii. of the Collected Researches of the National Physical Laboratory, form the starting-point of an investigation of great importance in electrical engineering. So little is known about the heat conductivity of materials in which cables are enclosed when in use that the views held by different authorities as to the greatest currents they will safely transmit are widely divergent The National Physical Laboratory is obviously the authority to whom a difficult subject of this kind should be referred, and electrical engineers will look forward with confidence to the publication of further reports.

PALM-OIL, which is used in very large quantities in the soap industry, is bleached (1) by exposure in thin layers to air and sunlight; (2) by blowing air through the hot oil; (3) by the action of bleaching-powder, or chromic acid. The very great development in this country and elsewhere of catalytic reduction, as a means of hardening fats and oils, appears to have suggested the desirability of applying similar methods to the oxidation and bleaching of the oils. The experiments of Mr. S. G. Sastry (Trans. Chem. Soc., 107, 1828) showed that a large number of metallic compounds could be used to stimulate the oxidation, the most effective being those containing manganese and cobalt, although nickel, iron, and lead were also active. Of the various compounds employed the borates were found to be more efficient than the oxalates, palmitates, sulphates, or oxides, and the most efficient of a dozen catalysts was cobalt borate. Using only 0·01 per cent. of this salt, a reddish sample of oil was bleached white in the course of 3½ hours by passing air through it at 80° to 90° C. The bleaching was found to be permanent during fifteen months, and did not destroy the faint odour of violets which is characteristic of the oil; the bleached oil also gave a colourless soap, and its soap-making qualities were not interfered with in any way.

AN account of a research on stable biplane arrangements, conducted at the wind tunnel of the Massachusetts Institute of Technology, is given in *Engineering* for January 7 and 14. The author is Mr. J. C. Hunsaker, assistant naval constructor in the United States Navy. The object of the research was to discover whether the longitudinal instability of the typical cambered aeroplane wing may be overcome without material sacrifice of lift, or increase in resistance. It is believed that the experiments show that the ordinary biplane, using wings of standard section, may be made longitudinally stable by giving the upper plane a stagger forward of 50 per cent. of the chord, and at the same time inclining its chord about 2½° to the lower chord, "decalage" 2½°. The loss in maximum lift to drift ratio ("efficiency") is less than 5 per cent. The maximum possible lift is not diminished, but increased slightly, and the landing speed of the aeroplane is thus the same whether this arrangement or the ordinary one be used. Further, the maximum speed is identical in both cases. In practice, the unstable pitching moments of ordinary biplane wings are balanced by a large horizontal tail surface. The increased structural weight due to inclined struts in a staggered biplane should be compensated, at least in large part, by the saving in weight due to a smaller tail surface and lighter supporting structure.

Engineering for December 31 contains a paper on recent progress with the active type of gyro-stabiliser for ships, read by Mr. Elmer A. Sperry at the Society of Naval Architects and Marine Engineers, in New York, on November 19 last. The paper describes the first commercial gyroscope-stabilising equipment to be installed, which was fitted on the yacht *Widgeon*, owned by Mr. H. M. Hauna, jun., of Cleveland. This was placed in service in the autumn of 1915. The system of control is practically identical with that adopted in former experiments on the *Worden*; a small auxiliary gyro feels out the incipient rolling of the ship by closing electrical contacts, and, through a relay switch, actuates a small reversing motor, which is geared to the case of the stabilising gyroscope and causes it to precess in its bearings. The stabilising

gyroscope then exerts a powerful restoring couple on the frame of the ship. The arrangement appears to have been very successful, and rolls of 25° on each side of the vertical have been quenched to 3°, the quenching being accompanied by much steadier steering. By no means the least interesting part of the paper is the collection of accompanying photographs and drawings of the arrangement; some of the latter are from working drawings, and enable the construction of the gyroscope to be understood perfectly.

DR. J. E. STEAD has collected the results of analyses of a large number of German shells and has given them recently in a paper read before the Cleveland Institute of Engineers, and reported in the *Engineer* for January 14. Dr. Stead discusses our own specifications for shell steels. The actual tests applied to such steels are confidential, but it is of interest to note that Dr. Stead, speaking as an analytical chemist, is of the opinion that no shell steel should be rejected on the results of chemical analysis provided the mechanical tests are satisfactory. Our enemies are not particular in having shell steel of uniform quality; the steel used is generally of relatively high tenacity, and is much more liable to break up by shock than what we produce and prescribe. It is most probable that some of the German shells are made by the basic Bessemer process, judging from the relatively large amount of nitrogen present in one of the toughest and best fragments, which also contained 0·07 per cent. of sulphur and phosphorus. The analysis of armour-piercing shells agrees with that of similar material made in other countries. German shells with between 0·07 and 0·1 per cent. of phosphorus did not burst in the gun, hence it seems probable that great freedom from that element has been found to be unnecessary.

OUR ASTRONOMICAL COLUMN.

COMET 1915*e* (TAYLOR).—There continues to be a dearth of information regarding this comet. Its actual position now differs very considerably from the only ephemeris available. Thus on January 13, 11.0 p.m., an observation made at the Hill Observatory showed that the ephemeris required corrections of +4·0 min. in R.A., and −1° 15′ in declination. The comet was easily seen in spite of strong moonlight, and was bright enough to show the cross wires in the eyepiece.

Employing observations made at Rome, December 5, Bergedorf, December 18, and on January 3, 1916, at Bamberg, M. J. Braae and Mlle. J. Vinter-Hansen have calculated the following elliptical orbit and ephemeris:—

Epoch 1916, *January* 0·5 *G.M.T.*

$$M_0 = 355°\ 15'\ 49''·3 \qquad \phi = 32\ 54\ 20·6''$$
$$\omega = 354\ 39\ 37·6 \qquad \mu = 564·209''$$
$$\Omega = 113\ 57\ 46·5 \qquad \text{Log } a = 0·533378$$
$$i = 15\ 28\ 9·1 \qquad T = 1916 \text{ Jan. } 30·7205 \text{ G.M.T.}$$
$$U = 2297·02\text{d} \quad (6·29 \text{ years}).$$

12h. G.M.T.

		R.A. h. m. s.		Dec. ° ′
Jan. 20	...	5 8 39	...	+15 47·2
22	...	9 38	...	16 38·3
24	...	10 49	...	17 28·9
26	...	12 12	...	18 18·9
28	...	13 48	...	19 8·1

The comet's distance from the earth has been slowly increasing. The comet is stated to be about eleventh magnitude.

COMET 1915*d* (MELLISH).—We are informed by Prof. Edwin B. Frost, director of Yerkes Observatory, that Mr. John E. Mellish has taken up residence there as volunteer research assistant. Comet 1915*d* was found with the 6-in. comet seeker, and Prof. Georges Van Biesbroeck, who is spending the year at Yerkes as visiting professor of practical astronomy, subsequently obtained the accurate positions of the comet using the 12-in. telescope and filar micrometer (see NATURE, December 2, 1915).

MIRA CETI.—American observations of this variable star during the 1914–15 cycle show that from a minimum of 9·0 mag. on October 15, 1914, the brightness increased to a maximum of 3·6 on February 11, 1915. By August it had again fallen to nearly 9·0 mag. (*L'Astronomie*, December, 1915). With regard to the present maximum, unless undue weight be given to an observation made on December 27 through a momentary rift in clouds, this star did not quite attain to the magnitude of α Ceti (2·7). Although it is still the next brightest star in the region, it now appears distinctly weaker than at the beginning of the year.

SECOND TYPE STARS OF LOW DENSITY.—At the present time the crucial evidence on the question of stellar evolution is stellar density. Numerical data accumulates which more and more insistently proclaims the existence of stars extremely different in mean density, yet capable of giving rise to almost identical spectra. As these data result from complicated calculations of orbital elements, Dr. H. Shapley has successfully sought for a method of deriving limiting mean densities merely from length of period and the duration of eclipse. The results obtained by this direct method are in close agreement with those already published in his "Orbits of Eclipsing Binaries" (Proc. Nat. Acad. Sci., vol. i., p. 459).

THE DISTRIBUTION OF SPECTROSCOPIC BINARIES OF CLASS M.—To the already long list of objects showing a preference for low galactic latitudes must now be added the spectroscopic binaries of class M (Antarian). C. D. Perrine (*Astrophys. Journ.*, xlii., p. 370), dealing with ten such binaries, finds the average galactic latitude is 9°, whilst omitting one (β Andromedæ), the average sinks to 7°. Orbits are available for only α Orionis and α Scorpii. Comparison with the Cepheid variables discloses some significant resemblances and differences, *e.g.*, light variations, small proper motions, and for the two known orbits the masses of the secondary bodies are similar, whilst some of the differences pointed out are the large value of $a \sin i$, and consequently periods measured in years instead of days.

REPORT OF THE NIZAMIAH OBSERVATORY.—The annual report (1914–15) of the Nizamiah Observatory (director, Mr. R. J. Pocock) shows that work on the astrographic chart has been actively advanced both as regards number of plates secured with the recently installed astrographic equatorial, and their measurement, although, through illness, the director had unfortunately to spend some weeks in hospital.

THE VARIABLE NEBULA, N.G.C. 6729.—There is very little definite information of the light variations of nebulæ, notwithstanding the great importance of the matter. Perhaps this apparent neglect is merely a measure of the atmospheric humidity where most observational work has hitherto been carried on. At Helwân, however, Mr. Knox Shaw has been able to make a good beginning with a photographic study of the well-known nebula N.G.C. 6729—the fan-shaped

appendage of the variable star R Coronæ Australis. Some results obtained since 1911 are described in a preliminary note (Bulletin No. 16). It is found that the nebula is bright when R Coronæ Australis is bright, and selectively variable areas have also been noted.

BRITISH RAINFALL IN 1915.

A DIGEST of the rainfall returns over the British Isles for the year 1915 is given in the *Times* of January 18 by Dr. H. R. Mill, director of the British Rainfall Organisation. For the purpose of the discussion 130 stations, scattered over the British Isles, have been selected from a total of 3000.

A table shows for each of the 130 stations the rainfall for 1915 with the average fall for thirty-five years, and the difference of 1915 from the average, also the percentage of 1915 fall on the average. The heaviest rainfall at the 130 stations was 103·52 in. at Seathwaite, and the least 24·56 in. at Bury St. Edmunds. Other records as yet to hand give 138·99 in. at Llyn Llydaw, in Snowdonia, and 138·97 in. on the Stye, overlooking Borrowdale, in Cumberland, whilst at Huntingdon the fall was only 23·99 in., and at Cambridge 23·00 in.

The percentage of the average rainfall for the year over the British Isles is given on a map which shows at a glance that the most excessive rainfall occurred in the south-east of England, south of the Thames, where the fall was 130 per cent. of the average. From the Bristol Channel to Mid-Norfolk there is a belt with practically normal rainfall, whilst to the north of this in the Midlands the rainfall was relatively higher. The east coast, as far north as the Moray Firth, had a rainfall in excess of the average. The whole of the west of Scotland and the north-west of England had a rainfall below the average; the deficiency was greatest in the West Highlands. The lack of rainfall in the north-west of Great Britain is said to have been a feature of the year's weather as striking as the excess in the south. In Ireland the distribution of rainfall during 1915 was not very different from the normal. For the British Isles as a whole there was practically an average rainfall with a tendency to excess rather than deficiency.

A table is given showing the general rainfall for the several months. The winter months—January, February, and December—had the greatest excess of rain in England and Wales, whilst the heavy summer rains in July were slightly the heaviest in Ireland.

The rainfall in London for 1915 was 28 per cent. above the average, the year being the wettest in fifty-nine years, with five exceptions—in 1903, 1879, 1878, 1872, and 1860; whilst the number of days with rain was 7 per cent. below the average. Rain fell for 568·9 hours, which is 136·1 hours above the average, and the highest in thirty-four years, except in 1903 and 1909.

SCIENCE AT EDUCATIONAL CONFERENCES.

II.

A PREVIOUS article (January 13) summarised the papers and discussions at conferences of teachers with reference to the national aspect of early training in science. The number and variety of the meetings was so great that many other points of general scientific interest deserve notice. First may be placed the exhibition of scientific apparatus at the meeting of the Public School Science Masters' Association, as it marks a new era. Formerly a large proportion of the laboratory ware and appliances were of German or Austrian origin; this year, with the exception of a few balances from Rotterdam, all the exhibits were British. Naturally, the size of the display was reduced, but there was no falling off in quality. So far as visual and handling tests can be trusted, the goods shown were of a high grade of material and workmanship. There was a large selection of electrical apparatus, mostly measuring instruments, suitable to all grades of teaching, from the most elementary forms of magnetometers or electroscopes to the elaborate potentiometer sets. Messrs. Philip Harris, F. E. Becker and Co., Gallenkamp and Co., and Gambrell Bros. all contributed to this section. Messrs. Baird and Tatlock (London) made a special feature of laboratory glassware, and a number of science masters paid a visit to their works at Walthamstow. Messrs. Philip Harris exhibited lamp-blown glass apparatus suitable for volumetric and research work, also moderately-priced strong instruments suitable for field-work in physical geography and meteorology. Balances were also a strong feature in the exhibits of the above-mentioned firms, and of Messrs. Townson and Mercer, the last-mentioned providing a good variety of glass apparatus. It was satisfactory to observe that those essentials, best quality porcelain and filter papers, have not been neglected. There is evidence that the efforts of the British Science Guild have stimulated the manufacturers; without doubt the guild, by bringing before the Government the fundamental importance of the supply of scientific apparatus, has done a great service to science teaching. It is inevitable that prices should be advanced, and doubtless there will be some shortage in the supplies here and there; but it is a matter for congratulation that the main requirements are being so well met by British firms under conditions of exceptional difficulty.

Exhibitions of books were held at the University of London, and also at the Science Masters' and the Assistant-Masters' meetings. New scientific books are being steadily issued, and the general state of the book-trade, so far as leading publishers of educational works are concerned, appears to be far more normal than could have been anticipated. This implies that instruction is proceeding with but little disturbance.

The inventiveness of the Science Masters shows no diminution. The Rev. W. R. Burton (Sandwich) showed several of those simple and cheap devices which combine the merits of economy with pedagogic effectiveness. An instance was an electroscope costing one shilling, the main insulator being a piece of candle deprived of its wick. Mr. D. R. Pye (Winchester) showed a most effective wave-motion model; even more educative was his model illustrating diffraction at a straight edge, of light from a point source. From Rugby came an admirable exhibit of chemical preparations made during the summer holidays, under the direction of Mr. E. R. Thomas. The Rugby exhibit included useful devices in the fitting of apparatus, and stereochemical models made almost instantaneously by the use of plasticine—a useful lecture "tip." To the present writer it seems a pity that these exhibitions should not be accessible to a larger number; if they could be transferred to South Kensington as soon as the P.S.S.M.A. meeting was concluded, their sphere of stimulating usefulness would be widened.

Mr. M. D. Hill (Eton) opened a discussion on "School Museums," the general outcome of which was the importance of frequent change in the objects shown, and the relatively great value of living objects, aquaria, etc. The curator must regard the function of the museum as dynamic rather than static. It was so much easier to follow the arguments of the speakers whenever the hearer knew the buildings in which the work was done, that it is here suggested that the British Association committee which is dealing with the subject should obtain a collection of photographs and lantern-slides of school museums.

The meeting of the Science Teachers' Association was largely attended by science mistresses, the proportion of men present being small. Miss Durham gave a lucid account of Mendelian laws, and described successful researches on the heredity of mice, canaries, and primroses. The association has recently formed small committees with the object of making it easier for teachers in schools to follow the growth of various branches of investigation. During the past year some papers have been read and circulated among members, of which we may instance "Development in Chemistry during the War," by Miss S. T. Widdows. Membership of the association is open to science masters, and it is hoped that those who realise the value to the nation of science in the schools and desire to promote efficiency by combined effort will communicate with the honorary secretary, North London Collegiate School, Sandall Road, N.W., with a view to membership.

These notes may finish with a quotation from the address on "The Teaching of Imperial History," by Sir Charles Lucas, to the Historical Society:—"What differentiated modern from ancient and medieval history was science and scientific invention. Scientific teaching has never been treated as the central and omnipotent force in the life of the nation, but democracy is the direct result of scientific invention and not of Acts of Parliament. The history of the past fifty years has been a record of the manner in which scientific invention has helped us by federating the different groups of Dominions." G. F. DANIELL.

MODERN SYSTEMS OF INDEPENDENT LIGHTING AND HEATING.[1]

III. *Lighting by Electricity.*

THE problems of lighting country houses by electricity vary greatly according to the size of the installation. The owner of a large country house has the advantage of being able to afford a competent engineer, and, since he generates on a large scale, he may obtain electricity at a relatively cheap rate, in some cases even at a lower rate than that ordinarily allowed by the local supply company. On the other hand, many country mansions are but little used by their owners during a great part of the year. This intermittent demand for electricity is a drawback, as it does not conduce to economy, and makes it difficult to maintain the plant in a state of continued efficiency. It is naturally inefficient to have a large engine and dynamo running to supply only a few lamps.

In small houses, on the other hand, the demand, though comparatively small, is more constant. It is probable that in such cases, taking due account of the running cost of generation, the interest of the original cost of the plant, and the repairs to the plant and batteries, the cost of generation will probably not be less, and may be more, than 4*d.*–6*d.* a unit; however, with some of the most recent automatic types of plant, generation at a rate of 2*d.* per unit is said to be practicable.

In a large country house the source of power may be a steam engine or an engine run by suction gas or oil gas. When water-power is available a water-turbine would probably prove the most economical and convenient source of energy. It is also necessary to instal a battery of accumulators in order to provide a steady voltage, and the usual arrangements for the control of the supply, including the switchboard, measuring instruments, resistances, etc., must be provided. It is generally agreed that the current of accumulators alone gives the most steady source of supply, and accordingly the battery may be used for the lighting during the evening and charged during the day. Special arrangements may also be made to run the lights from the battery and dynamo in parallel. One advantage of a large battery, as well as a dynamo capable of supplying the entire load, is that one has an emergency supply in case of the engine breaking down. The maintenance of the battery in good order is one of the chief difficulties in those installations where little current is used during the summer. Accumulators ought to be charged and discharged at regular intervals. There are even cases in which it is necessary occasionally to discharge the battery through a resistance as an "artificial load" during the summer, thus wasting current in order to keep the cells in good order.

It is very difficult to quote definite figures of the cost of country lighting installations; generally speaking, the cost for a fairly large installation, including the plant, battery, and switchboard of mains to the house, might work out as follows:—

No. of lights (16 c.p.)	Initial cost of plant, etc. £
25–30	100
40–50	130–150
80–100	150–170
200	200–220

To this must be added the expenditure on fittings and the cost of internal wiring. The cost of wiring in country districts may be as high as 25*s.* to 35*s.* a point. It is remarkable how the expenditure under this heading varies, especially in converting old mansions, where unexpected obstacles in wiring, due to the structure of the building, are often met. In many cases it is also desirable to allow a fair margin in estimating as to the size of the plant, as it is often useful to have electricity available for other purposes, such as heating radiators and driving pumps and agricultural machinery, etc. In large country houses with a big plant, electric radiators are frequently used for heating rooms. The small consumer, however, will scarcely go to this length, but may make good use of small heating accessories, such as electric kettles, irons, etc.

The possibilities of electricity for lighting a country house have been much simplified by the introduction of the metal filament lamp, the improved efficiency of which as compared with carbon filaments makes it possible to light a house of a certain size with a much smaller plant. It is usual to work at a pressure of 50 volts for lighting, as this enables metal filament lamps to be used under the most efficient and economical conditions. Small candle-power lamps having stout filaments and exceptional durability are available for 50 volts. On the other hand, if power is to be transmitted a considerable distance the cost of mains becomes an important item, and it may be desirable to raise the pressure to 110 volts in such cases, so that the current to be carried by the cables may be diminished.

To the small householder, the care of the plant is naturally an important item, and he may have to rely to a great extent on his personal efforts in this direction. It is therefore essential that a plant for small users should be as simple and easy to operate as possible. For small installations, the usual practice is to employ a dynamo driven by a small petrol engine. During the last few years there have been great improvements in the simplification of such plants, which have reduced the attention necessary to a minimum. In particular, devices have been adopted to enable the plant to run automatically, ceasing to generate when all the lamps are turned off, in the same way as a petrol-air gas plant.

[1] Continued from p. 553.

One of the best known automatic plants of this type is the "Lister-Bruston." This plant has been specially designed with the view of avoiding the expense of the large batteries of accumulators ordinarily demanded by country-house lighting. The plant consists of a dynamo driven by an internal-combustion engine, but only a small set of accumulators is needed. These accumulators are sufficient to supply three or four lamps without running the plant. When, however, more lights are switched on, the current demanded by the lamps causes a relay, or automatic switch, to make contact, and the current from the battery then passes to the dynamo, which rotates for a few seconds as an electric motor, this starting the engine. From this point onwards the load is taken up by the engine and the dynamo, the battery, however, being in parallel. By this means the battery is kept charged, and has a steadying influence upon the electric pressure. In the same way, when the lights are sufficiently reduced, the relay breaks the circuit to the dynamo and the engine stops, the few remaining lights being again run by the accumulators.

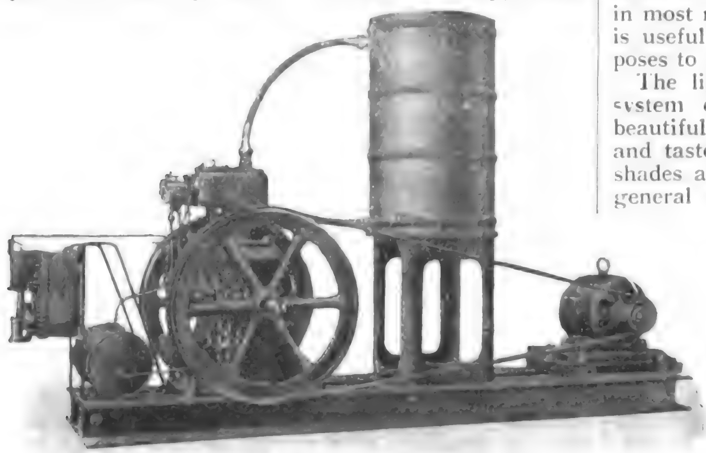


FIG. 1.—The Lister-Bruston electric generating plant. A petrol-driven engine drives a small dynamo, supplemented by a battery of small accumulators. By means of a special relay switch (shown on the left) the battery starts up the engine when more than a few lamps are put on. Similarly the switch is automatically released and the engine stops, when the load falls below a certain value. The plant is thus automatic in action and only a small battery is needed.

The plant is thus automatic in action, and is not run when the load is very small. In the event of the engine failing, the load will be taken up by the battery for several hours while the defect is put right. One advantage of the system is that the charging of the battery is automatically attended to, and the danger of permanent damage owing to the cells being allowed to remain uncharged for a long period is avoided. The success of such an automatic system demands an exceptionally robust type of cell, but it is claimed that these cells can be left to themselves for a long time without deteriorating. The firm also undertakes to keep plant and battery in order for a small annual sum.

While this system is mainly intended for lighting for country houses, it has also been applied to the lighting of small villages. In this case, the usual arrangement is to have several engines of varying capacity, which are automatically switched into circuit as the load increases and disconnected when the demand is small. This ensures that the plant is always working at full output and maximum efficiency.

Finally, a few words may be said on the illumination of country houses in general. It is most essential that the arrangement of the lights in the house should be carefully studied. Cases are sometimes encountered where a large, and even an unnecessarily large, plant has been installed, and yet the electricity available is not used to the best advantage. It is necessary to consider the purpose of the lamps in each room, and their positions should be selected with care. Bare metal filaments are inconveniently bright, and appropriate shades, softening the light and distributing it where it is chiefly needed, should be provided. By attending to these points it is often possible to manage with a much smaller plant than would otherwise be necessary. When electric light is used, the consumer should be cautioned against undue economy in the matter of switches and plugs. It is best to arrange for full control of the lights, so as to avoid the waste of burning an unnecessary number; in most rooms a series of plug outlets round the walls is useful in enabling portable lamps for special purposes to be employed.

The light should also be regarded as part of the system of decoration of the room. An otherwise beautiful interior may be marred by an incongruous and tasteless fitting; on the other hand, appropriate shades and fixtures harmonising with the colour and general style of decoration of the room add to its effect.

In converting old mansions to modern illuminants, considerable skill and artistic perception are often needed. Moreover, the lighting of each particular room, hall, dining-room, drawing-room, kitchen, bedroom, etc., presents a different problem. On the care with which this problem is studied the whole utility of the generating plant depends.

Petrol-Air Gas for Heating.

IN the article entitled "Modern Systems of Independent Lighting and Heating" in NATURE of January 6, p. 522, the section dealing with heating was necessarily curtailed, and Mr. W. Willett directs our attention to one point relating to his petrol-air gas system on which further explanation is needful. It should be explained that either a rich or a poor mixture of petrol and air can be obtained, the richer mixture being preferred for heating. For example, as stated, with the Willett plant a mixture of 2 per cent. of petrol is recommended for lighting; but the plant can be worked at either a 2 per cent. or a 6 per cent. mixture, according to the use for which it is intended. In country laboratories a richer mixture than 2 per cent. would be employed. Those selecting a plant would naturally turn to the makers for fuller particulars on this point.

THE BONAPARTE FUND FOR 1915.

THE committee appointed by the Paris Academy of Sciences to examine the requests for grants from the Bonaparte Fund make the following proposals, which have been confirmed by the academy:—

3000 francs to Auguste Lameere, professor at the University of Brussels, to enable him to continue his researches at the Roscoff Zoological Station.

4000 francs to Charles Le Morvan, assistant astronomer at the Paris Observatory, for the publication of a systematic and photographic map of the moon.

2000 francs to Paul Vayssière, for the continuation

of his researches on the various species of cochineal insects.

3000 francs to François de Zeltner, to contribute to the cost of a proposed expedition to the Sudanese Sahara, more particularly in the Air massif.

2500 francs to Léonard Bordas, to assist him in pursuing his investigations relating to insects attacking trees and forests, and more especially species which at the present time are devastating the woods of the central plateau and west of France.

3000 francs to Joseph Bouget, botanist at the Pic du Midi Observatory, for realising his cultural experiments on a larger scale, with special reference to the improvement of the pastures of the Pyrenees.

3000 francs to Henry Devaux, professor of plant physiology at Bordeaux, for the continuation of his researches on the cultivation of plants in arid or semi-desert regions.

2000 francs to Victor Piraud, for the continuation of his studies on the fauna of Alpine lakes and torrents, particularly at high altitudes.

2000 francs to Marc Tiffeneau, for the continuation of his studies on the phenomena of molecular transposition in organic chemistry.

THE PRINCIPLES OF CROP PRODUCTION.[1]

IN any discussion of the principles of crop production it is necessary to begin with the year 1840. By that time it was definitely known that plants consist mainly of organic matter along with a little mineral matter—phosphorus, calcium, potassium, sodium, etc.—to which, however, very little importance was attached. The practical man knew that farmyard manure was the great fertiliser; he also knew that other substances, bones, salt, etc., had, in certain circumstances, considerable fertilising value. The most obvious facts were the large amount of organic matter in the plant and the large amount of organic matter in the best manures; and it is only natural that chemists and physiologists should have connected these, and argued that the object of the manure was to furnish organic matter for the plant.

By a brilliant stroke Liebig, in 1840, brushed aside this obvious connection and declared that the true function of the manure was to provide, not organic matter, but the mineral constituents which the chemists had ignored. The first step, he said, was to find out what mineral constituents the plant contains, and then to supply these substances in a suitable form. If any one of them is lacking the soil is rendered infertile, and matters will not be put right until that one is added. Thus the whole art of manuring was reduced to an exact science.

Unfortunately Liebig's prescriptions failed in practice. The Rothamsted experiments showed that his ash constituents gave little better crops than no manure at all. Liebig had left something out; it was necessary to add nitrogen as well before complete growth could be obtained.

The critics urged that the effects would only be temporary; that in time the land supplied with "artificials" would give out. Experience has shown that this is not so; similar good results have been obtained at Rothamsted over the long period of more than sixty years (Fig. 1).

Part, therefore, of Liebig's principle is perfectly correct: the mineral constituents are indispensable and must be supplied to the plant. The mistake was to suppose that they were sufficient. We may take it as established that crops can be grown satisfactorily and indefinitely by supplying proper quantities of suitable compounds of nitrogen, phosphorus, and potassium. This we can call our first principle. Difficulties arise, however, directly one tries to develop it in practice. Trouble began with the attempts to find out what are suitable quantities to use. Liebig had supposed that the requirements of a crop could be gauged by the composition of the ash. Lawes and Gilbert showed that this was not the case. Thus the ash of the turnip crop contains a considerable amount of potash but only little phosphate; according to Liebig, it should have required mainly a potassic fertiliser. Lawes and Gilbert showed, however, that it required phosphates and not potash, and they concluded that the special requirements of a crop could only be discovered by actual trial.

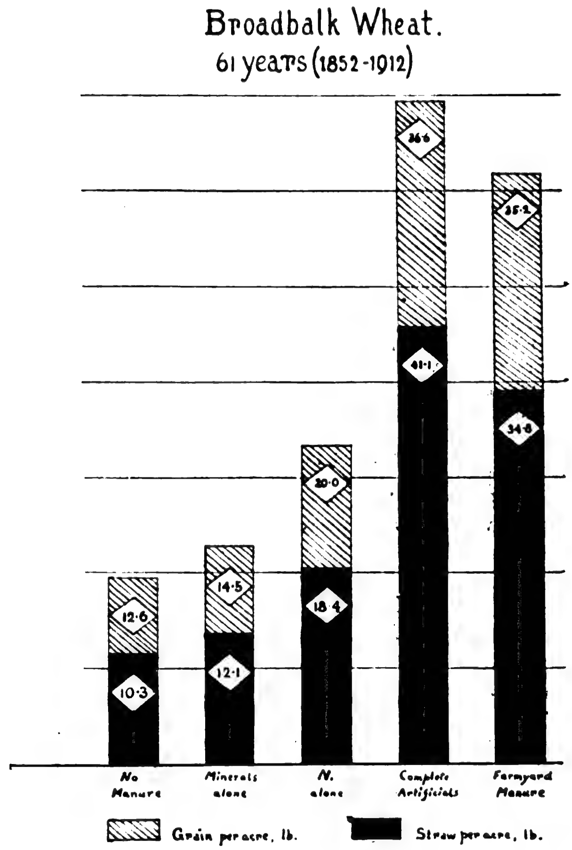


FIG. 1.—Yield of wheat on the Broadbalk plots, average of sixty-one years' results. (The figures in the diamond-shaped spaces denote bushels of grain and cwts. of straw respectively.)

When nitrogen compounds are withheld the yield is little better than on the unmanured plot. Complete artificial fertilisers give a full crop which is fully maintained to the present time, and in this case is better than that given by farmyard manure.

This view was developed in the 'sixties in a series of brilliant lectures by Ville. After numerous experiments (he says "many thousands"), he drew up the following list, showing the special need, or, as he called it, "the dominant," for each crop:—

Ville's List of Dominants.

Nitrogen	for	Cereals.
,,	,,	Beetroot.
Potash	,,	Potatoes.
,,	,,	Vines.
Calcium phosphate	,,	Cane-sugar.
No dominant	,,	Flax.

In order to ascertain the special needs of the crop on a particular soil, he grew the plants on a series of plots, one of which was given the complete manure,

[1] Lecture delivered before the Chemical Society on November 18, 1915, by Dr. E. J. Russell. Abridged from the Journal of the Society for December, 1915.

whilst the others each had one constituent left out. Thus for wheat he obtained the following results, and, therefore, concluded that on this soil wheat requires a good supply of nitrogen, less phosphorus, and still less potassium :—

	Crop per acre. Bushels.
Normal manure	43
Manure without lime	41
,, ,, potash	31
,, ,, phosphate	26½
,, ,, nitrogen	14
Soil without manure	12

The method, of course, is perfectly sound, and it has been very widely adopted. It is, however, frankly empirical, and empirical work is never very inspiring, so that for a long time soil work came rather to a standstill.

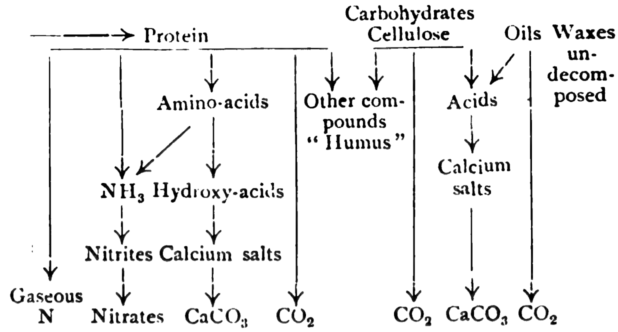
It has several times happened in the history of agricultural chemistry that the new illuminating idea wanted to revivify the subject at a stagnant period has come in from some outside technical problem that had to be solved. So it was here. The growth of the towns and of stricter ideas on public health had brought into prominence the need for better sewage purification, and it was imperative that the problem should be dealt with somehow or other.

Schloesing and Müntz found that satisfactory purification involved the conversion of ammonia into nitrate, and by a brilliant investigation they found that this process was neither chemical nor physical, but biological. Their work was extended to the soil with remarkable results. It was seen that the soil was not a mere inert mass, but that it was teeming with life and pulsating with change. The number of bacteria is enormous, running into millions per gram, and the question is raised: How do these organisms live? They must have food, and they must have energy. We are therefore forced to go back to the soil and study it as a medium for the life of a soil population.

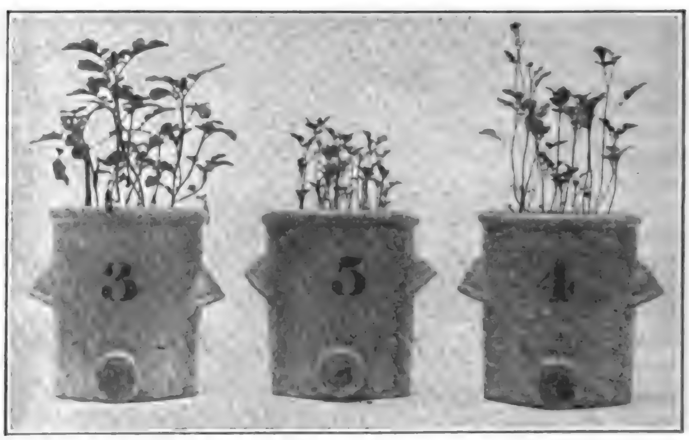
A very cursory examination shows that the soil forms only a thin layer; underneath it lies the subsoil, which is wholly different in colour, texture, and especially in its behaviour towards the plant (Fig. 2).

Yet there was not always this difference. When the soil was first laid down it was all like the subsoil, and whenever a new surface becomes exposed, either by landslips, cliff-falls, etc., it is always the subsoil type that appears. The first vegetation has no great supply of plant nutrients, but plants suited to the conditions nevertheless spring up. They take what they can from the crude soil, they take carbon dioxide from the air, they synthesise sugars, starches, cellulose, proteins, etc., deriving the necessary energy from sunlight. When the plants die they fall back on the soil and return to it all that they took, and a good deal more of new material besides. That introduces a fundamental change.

The new material thus added contains stores of energy and food substances suitable for the bacterial population, which forthwith flourishes. Decomposition goes on, nitrates and other substances are produced, and the conditions are made more favourable for the growth of a new race of plants. One of the most obvious changes is the formation of nitrates, but other products are formed as well. It is proving exceedingly difficult to trace out full details, but the following is probably in the main accurate :—



Unfortunately, not much is known about the details, but the reaction is extremely important. The initial products are of little value to the crop or the soil. The final products are invaluable for plant nutrition, and some of the intermediate products are very valuable for the soil. This, therefore, is the reaction on which plant nutrition depends, and it is of the highest importance that it should proceed rapidly and smoothly. Where for any reason it does not, the soil becomes unproductive.



Soil Sand Subsoil

FIG. 2.—Plants grown in soil, sand, and subsoil respectively, all without manure, showing the marked differences in behaviour towards the growing plant.

Scientific crop production depends largely on controlling this reaction. Three things are necessary: the conditions—the air supply, water, temperature, etc.—must be favourable; the organisms must be of the right kind; and the supply of raw material—plant residues—must be kept up.

We shall see later on how the favourable conditions are obtained. Hitherto little has been done to control the organisms beyond improving the conditions, but beginnings have been made in the direction of inoculation and partial sterilisation. The supply of raw material is kept up in several ways; probably the oldest is to leave the ground alone, so that it covers itself with wild vegetation, which is then ploughed in. This formed part of the Mosaic law; it was the regular medieval custom in our own country, and it is practised to this day in Connemara. It is too haphazard for modern use, however, and so nowadays the farmer grows a special crop with the express intention of ploughing in all or part of it, or of feeding it to animals and ploughing in the excretions.

The second broad principle of crop production is,

then, that the biochemical decompositions in the soil must proceed smoothly and rapidly.

New difficulties arise as soon as one begins to develop this principle. Reverting to the scheme just given, it is seen that the decomposition of proteins may proceed in two ways, either ending with nitrate or with nitrogen. Now the nitrate ending is desirable enough, but the nitrogen ending is highly undesirable. Yet this happens directly the process is speeded up too much. The more intense the cultivation becomes the more serious are these losses; they are bad on the prairies, but still worse under conditions of intense cultivation. To some extent this is inevitable; it is equally true of engines, but just as the engineer has increased the efficiency of engines, so the agricultural chemist has to increase the efficiency of the nitrogen utilisation processes.

Pot No. 47 55 63 72 79

FIG. 3.—Tomatoes supplied with increasing doses of nitrate of soda.

Pot 47.—No nitrate. Pots 55 to 79.—Increasing dressings of nitrate. This increases the amount of growth up to pot 72, but it depresses growth in pot 79, where too much is given. The middle pot, 63, is best for fruit. Phosphates and salts, potassium, calcium, etc., were given equally to all pots.

Unfortunately, the purely chemical work on the decomposition of protein has not gone far enough to enable a full working hypothesis to be mapped out. The decomposition does not stop at amino-acids; under bacterial action there is a further change to bases and acids. These are under investigation in several chemical laboratories, but the results have not yet helped us much. Here, therefore, we have an economic problem of the first importance waiting for the solution of a chemical problem which, at first sight, seems rather academic and remote from practice.

These biochemical changes, important as they are in crop production, do not end the matter. The soil comes directly into the reaction. The calcium carbonate neutralises acids produced during the decomposition. The clay and some of the other constituents possess colloidal properties, so that all these reactions proceed on a jelly-like surface and not in a fluid medium, and they are liable to be affected by all the complications produced by surface actions.

The plant plays an even more active part. Its roots absorb some of the products—the nitrates, the phosphates, etc.—and might therefore be expected to hasten the whole process; but this does not happen. On the contrary, the growing plant appears to retard it, and nitrate is always formed in higher quantities on fallow than on cropped land, even after allowing for what is taken by the crop.

Whether the growing plant affects the nature of the change or only the rate is not yet known. The essential point is that, so far as plant nutrients are concerned, neither the soil nor the plant plays an entirely passive part. The soil is not an inert medium, and the plant is not a mere passive bucket into which the products of the reaction are drawn; each plays an active part, disturbing both the reaction and the distribution of the products.

The recognition that the plant is a living thing has broadened our conception of the factors necessary for plant growth. In much of the literature of the 'seventies and 'eighties it is tacitly assumed that the whole art of crop production is a question of manuring. Whitney's investigations on American tobacco, however, led to the recognition that the type of the soil is an important factor in crop production, which has had some extremely interesting developments. Mechanical analyses to determine the type became an indispensable part of the routine of soil analysis. The perspective was restored, and the fact emphasised that the plant not only wants food, but also proper water supply, air supply, and temperature.

Now there is a very simple rule that applies to all these factors. Plant growth increases with increasing supply of any one of them, but this only happens so long as the supply of every other factor is adequate. When anything is lacking the increase in growth is not kept up, and additional supplies give no extra crop. Finally a stage is reached when extra supplies may do harm, either by direct injury or by cutting out another indispensable substance. This is shown in the tomato experiments of Fig. 3, where successively increasing doses of sodium nitrate are applied in the four pots 55, 63, 72, and 79, although no further growth is obtained in 72 and 79 because of the insufficient water supply. The conditions for favourable growth are all present in pots 72 and 79 excepting only this one, but it effectually prevents the plant from taking full advantage of the good conditions. All this is expressed in a generalised form in the curve of Fig. 4, which thus represents our third principle of crop production. It has only recently been revived in agriculture, although the fundamental idea is old; it can be found in the writings of the political economists of the Malthusian school; it was used in a special form by Liebig in his "Law of the Minimum"; it was developed by Horace Brown and F. F. Blackman. In its full generalised form it is proving extremely useful.

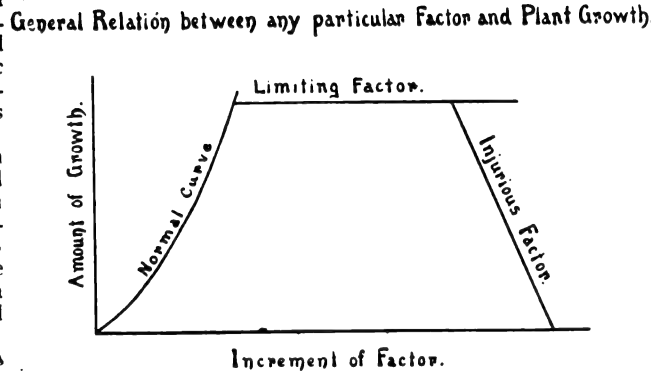


FIG. 4.—Increases in amounts of the various factors necessary for plant growth do not cause indefinite increases in growth. After a time some other factor becomes insufficient and operates as a limiting factor.

Problems of soil fertility generally have to be approached from this point of view. Whenever a case

of infertility has to be studied the first question to settle is: What is the limiting factor? And the next: How can this limiting factor be put out of action? As a rule the limiting factor is one of the following:—

Limiting factor.	Put out of action by:
Wetness	Drainage, liming
Dryness	Irrigation, suitable cultivations Addition of organic matter
Lack of temperature	Drainage and cultivation
Sourness or acidity	Liming or chalking

The removal, although simple in principle, may be very difficult in practice: it has often proved to be the rock on which many beautiful schemes for increasing food production have been wrecked.

We have seen that, broadly speaking, three general principles of crop production can be laid down:—

(1) The plant must have a sufficient supply of all necessary nutrients, especially of nitrogen, potassium, and phosphorus.

(2) The biochemical decompositions in the soil must proceed smoothly and quickly.

(3) All the requirements of the plant must be satisfied. Any one left unsatisfied constitutes a limiting factor preventing further growth. Increases in any one factor give increases in growth until something else proves insufficient and becomes a limiting factor.

We go back, then, to our three established principles. Each of these can be recognised broadly in every case of crop production, but considerable difficulties arise when one tries to develop any of them; there are so many factors involved and their interaction is so complex. I can best illustrate this by taking one of the factors in some detail, and I will choose one that has received very much attention from chemists, namely, the supply of phosphates.

Phosphates are indispensable for plant growth, and well conducted physiological experiments in sand have shown a simple connection expressible by a mathematical equation between the amount of phosphate supplied and the amount of growth. But such simple results are never attained in soil. To begin with, there is always some phosphate already present. At first sight it looks easy enough to take account of this, and simply add it on as a constant in the equation. It has proved almost impossible, however, to give any precise value to the amount of phosphate in the soil that is of any use to the plant. Ville showed years ago that the amounts revealed by chemical analysis are far beyond anything the plant can ever get, and he rather gloomily concluded that "chemistry is powerless to throw light on the chemical properties of the soil." One could scarcely expect chemists to acquiesce in that view, nor did they. Instead of using strong acids, they used dilute acids; several were suggested, and by a happy inspiration Bernard Dyer selected 1 per cent. citric acid as being the most suitable; although that was twenty-one years ago, 1 per cent. citric acid still holds the field in this country.

The part extracted by dilute acids was called the "available" portion to distinguish it from the "unavailable." The new method at once proved very helpful; difficulties, however, began to arise. It was found impossible to assign any definite value to the amount of available phosphate present. Variations in the conditions of the experiment gave wholly different values for the amount of "available" phosphate, whilst in the case of nitric acid the longer the acid acted the less phosphoric oxide (P_2O_5) was extracted.

Now that gave the clue to the problem. It is obvious that there must be two actions going on: a direct solvent action and a reverse action, resulting in the withdrawal from the solution of the dissolved phosphoric oxide. The direct solvent action was found to be much the same for all dilute acids.

The reverse action proved to be the ordinary adsorption isotherm, similar in type to that obtained with charcoal and dilute acids. The constants are not the same for the different acids, and from these curves it is possible to go back and explain the apparently erratic action of the different acids on the soil.

Thus it appears that when phosphate is added to the soil for the purpose of increasing the growth of a crop it does not simply stop in the soil, waiting for the plant to take it up. It reacts with the soil; it is adsorbed, and the amount available for the plant at any time depends on the adsorption relationships. There is, in short, a competition between the plant and the soil for the phosphate. The curves for clay and sandy soils show that adsorption is greater for clay than for sand; in other words, the clay competes for the phosphate more vigorously than does the sand. An amount, therefore, which is sufficient for the plant growing in a sandy soil proves inadequate on a clay soil. This has thrown light on an interesting problem in manuring, for it has long been known that clay soils stood in more need of phosphatic manures than sands. The field results bring out this fact: the yield of barley on the heavy Rothamsted soil falls when phosphates are omitted, but it does not react nearly so quickly on the Woburn sand.

It seems a far cry from the logarithmic curve expressing an adsorption isotherm to the management of barley and turnips, but the connection is really simple and direct.

This, however, does not settle the matter. The plant is a living thing, and consequently its requirements are not rigidly constant, but vary with the conditions. There are very good grounds for supposing that the plant actually requires more phosphate on a clay soil than on a sand. The effects produced by phosphates are promotion of early growth, root development, and early ripening; they are specially valuable on clay soils, in wet regions, and for shallow rooting and quick growing plants, for example, swedes and turnips.

It is possible that some simple connection underlies all these, but no one has yet discovered it.

Again, seeing that the need varies with the conditions, it is clear that if the conditions are altered the needs may change. When, for instance, a dressing of farmyard manure is applied, some of the properties of the soil are altered; it becomes more porous and more retentive of water, and phosphates may behave differently from what they did before. That is well shown on the Saxmundham plots.

It is unnecessary to go any further. The point I want to bring out is that the simple and incontrovertible statement that phosphates increase plant growth proves very complex when applied in practice. So it is with the other factors. They can be disentangled and investigated, but it is not yet possible to put them together again and predict the resultant. One cannot set out from first principles and reconstruct the normal case of crop production; the factors are too numerous and too complex.

Yet something has got to be done. The technical chemist has the advantage over his colleague in the purely scientific laboratory that he cannot shelve an inconvenient problem. A method has been evolved, an empirical method, which, whilst not very rigid, has at least the merit that it works. It consists in going into the field and finding out the actual agricultural properties of the soil by observations, inquiries, and direct field experiments; these have to be repeated for two or three years because the first results may only have been a trick of the weather, but if the same

result is obtained for several seasons running, one may be sure of being right.

All that is old; it is, of course, Ville's method over again. The new part consists in trying to extend the results to other soils. For this purpose a soil survey of the area, usually the county, is arranged. In this way a collection is made on one hand of the agricultural properties, on the other of the chemical, bacteriological, and physical data, of typical soils. It is obvious that the possession of these standard soils helps the analyst and expert adviser very considerably; if a farmer asks for information it is much easier and safer to compare his soil with the standard than to attempt any absolute measurements. Moreover, these soil surveys are greatly facilitating advisory and analytical work.

They do far more than that, however. The normal case of crop production can never be decided on purely laboratory methods because there are always two or three varying factors, whereas in the ideal laboratory experiment there is only one factor varying. We are not, however, confined to the ordinary laboratory methods. Statisticians have to deal with problems involving two or three variables, and they have worked out a method—the method of correlation—which, when intelligently applied, gives valuable results. It is hoped to apply this to crop production. The necessary masses of data are slowly being accumulated, and it is anticipated that very interesting results will be obtained.

The ordinary laboratory method, however—the one factor method—may still on occasions work satisfactorily. It sometimes happens in nature that one of the various interacting factors overshadows all the rest and virtually eliminates them, so that here, too, it is possible to apply laboratory methods with satisfactory results.

For example, on a certain type of clay soil the whole situation is controlled by the circumstance that phosphates are almost absent, whilst the need of the plant for phosphates is particularly great. The addition of basic slag in these circumstances has caused most remarkable improvement. The best instances are seen at Cockle Park, and the results are given in their bulletins.

Another illustration is furnished by our work on the partial sterilisation of soils. The simplest explanation of the phenomena is that the soil population can roughly be divided into two groups: one favourable to the production of plant food, the other not. The useful population is, on the whole, more resistant to adverse circumstances than the harmful organisms, and therefore survives more drastic treatment. Hence any method that kills some, but not all, of the soil population effects an improvement and leads to good results. A continued spell of favourable conditions, however, enables the harmful organisms to establish some sort of superiority. This hypothesis throws important light on the behaviour of the soil in natural conditions, and it reveals another factor in crop production.

We have not yet succeeded in making much of it in the normal case; indeed, we have scarcely attempted to do so, because there are so many interacting factors. There are, however, cases where this one factor largely dominates the situation. In glasshouses run at a high pitch, where the soil temperature and water content are high, and where large dressings of organic manures are used, the bacterial efficiency falls off so much that the plants begin to suffer. The soil, in the picturesque language of the practical man, is said to become "sick." This sickness proved so difficult to deal with in practice that the soil was thrown out and new soil brought in to take its place.

It was not difficult, however, to suggest a remedy. The reduction of bacterial activity seemed clearly due to an excessive development of the detrimental organisms. It was only necessary to adopt partial sterilisation to get rid of these and to give the useful organisms a better chance of action. The basis of a suitable method was already in existence; steam had been used to kill insect pests in the houses, and by suitable modification this process was successfully used for the treatment of sick soils.

The most fruitful ideas for working out the development of our subject have often been got from abnormal cases brought in by the growers. Practical men have the great advantage that they are compelled to keep their eyes open for nature's problems; they cannot shirk them, or they find their crops suffering and themselves losing money. The close association of science with an industry is, therefore, a great advantage, because it brings in new problems which, if properly investigated, may prove extremely valuable in opening up new fields of knowledge. There is an exhilarating freshness about all this work that one often misses in the more academic investigations.

All the same, while speaking in praise of applied science, one must recognise that science cannot be applied until it is developed. We have seen, and instances might have been multiplied, how the hydrolysis of protein throws light on the proper management of a manure heap, and how the adsorption isotherm worked out for charcoal and dilute acids clears up a difficulty in the manuring of turnips. It is impossible to set any limit to the value of good work in science honestly carried out. The fact is that science and creative industry are one and indivisible, and any attempt to divorce them may only end in disaster.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE *Morning Post* of January 18 announces an anonymous gift of ten thousand guineas to King Edward's Hospital, Cardiff, towards the cost of new extensions.

THE *Times* of January 14 announces that Sir Alexander M'Robert has given to Aberdeen University an endowment of about 750*l.* per annum for a Georgina M'Robert lectureship on pathology, with special reference to malignant diseases.

THE National Diploma Examination in Agriculture of the National Agricultural Examination Board will be held at the University of Leeds on April 14 and following days, and examinations in the science and practice of dairying will take place in September at the British Dairy Institute, Reading, and at the Dairy School, Kilmarnock. Entries for the first-named examination must be sent in not later than March 1, and those for the latter ones not later than August 15.

THE December issue of the *Reading University College Review* is largely a record of the continued effect of the war upon the work of the college. All the conditions during the first year of the war have affected also the first term of the present session, but in greater measure. The number of men day-students at the beginning of the term had fallen to about forty, and of this number some left at the end of last term in order to undertake military service. More members of the academic staff have undertaken military or Government service, and others are likely to follow their example. Wantage Hall is again in military occupation, and the council has agreed to place rooms

and offices at the disposal of the Flying School which is about to be formed in Reading. Munitions work has been instituted in the physical laboratory, and the making of splints for use in hospitals is being carried on in the building devoted to craft work. The lists of military distinctions and of officers killed in action, as well as the list of present members of the staff, past and present students, and present servants of the college serving with the Forces of the King or in the French Army, printed in the magazine, are a splendid tribute to the loyalty and patriotism of the institution.

FOUR points relating to the place of science in education are dealt with by Sir E. Ray Lankester in a letter to the *Times* of January 14. The first consideration is that instruction in the elements of physics, chemistry, and biology must not be limited to the few, but be a part of the education of all; for they are equally necessary for the conduct of public affairs in a progressive spirit as for the development of industries. The view that attention to scientific knowledge necessarily leads to the barbarisms committed by our German adversaries is as illogical as it is untrue. The men who are responsible for the present conflict are not men of science but historians and other official advocates of world-power by Germany; and the military authorities have made use of whatever forces scientific discovery can give them. The third point referred to is that science in the public schools and universities is regarded as specialisation, whereas Greek and Latin and allied subjects are considered to be parts of a general education. This view is a legacy of past centuries, and should be the reverse of the truth for modern times, though classical headmasters will not understand the different needs of to-day, and will not depart from the ways of traditional instruction. Sir Ray Lankester places the chief burden of responsibility for existing conditions upon the Civil Service Commissioners, who assign an overwhelming excess of marks for classical and literary learning in examinations for the chief posts in the national service. He would give one-half of the possible total to science, which should be compulsory for all candidates, one-quarter to mathematics, and one-quarter to the classical and literary group; and he believes that "the one and only way of saving the country from utter inefficiency and consequent ruin is for the Legislature entirely to remodel the competitions for the valuable posts of the Home and Indian Civil Services."

AN interesting supplement on "War and Education" appeared in the *Times* of January 14. It is a commonplace that a great war is invariably followed by educational reform, and in the first article this is illustrated in English education from Alcuin to the South African war. It was the last-named which led to measures —medical inspection and provision of meals—for securing better physical care of school children. In most of the articles the importance of character training receives due recognition, the columns headed "A Lesson of Empire" and "Teaching Patriotism" being written with force and judgment. The editor directs attention to the great need of the immediate future, the training of boys and girls between the ages of fourteen and seventeen. At present two millions below the age of seventeen are receiving little or no education either in school or in skilled work. All who have given thought to the matter are in agreement as to the importance of educating our adolescents, both from the point of view of ethical training for citizenship and of increasing productive efficiency, but not all thinkers will agree as to the methods advocated by the editor of the "Educational Supplement." Dr. M. E. Sadler discusses the comparative merits of German and English education, and gives as the defects of English education: (1) too low a standard of *mental* training, hence failure to realise the value of pure science; (2) uninstructed parental opinion; (3) failure to stimulate intellectually the average boy and girl; (4) inertness of mind towards science in industry, public administration, and domestic management; (5) neglect of personal hygiene in its widest sense. British schools must impart love of knowledge and care for conduct; love of adventure and readiness to endure routine; capacity for individual initiative, and patience in the work of scientific co-operation. All the articles are useful so far as they go; it is a matter for regret that Dr. Sadler is alone in recognising the necessity for greater attention to science. The unfortunate and serious omission to give proper consideration to this vital need is a defect in an otherwise able and helpful symposium.

With the approval of the War Office, Colonial Office, and Board of Education, and of the High Commissioners of the Dominions beyond the Seas, an organisation has been formed with the title of "The Fighting Forces Book Council." This organisation, of which Lord Bryce is president, and Sir Edward Ward the chairman of the executive committee, is intended to supplement, and not in any way to overlap, existing bodies, such as the Camps Library, which is the recognised collecting and distributing depôt for the books sent through the medium of the General Post Office, the Red Cross, and St. John's Ambulance War Library, which supplies the hospitals, and the Young Men's Christian Association. Through the machinery of these various organisations large quantities of books —mainly light fiction—are being regularly distributed to the forces on active service, naval and military hospitals, and convalescent camps, both at home and abroad. It has been found, however, that books of a more solid kind are asked for by an immense number of educated men now in the military service of the Empire. The objects of "The Fighting Forces Book Council" are to try to meet this need, and at the same time to assist the existing organisations in every possible way. It proposes to: (1) raise funds for providing reading matter of the kind indicated above for his Majesty's Forces at home and abroad, including the wounded and convalescent and the British prisoners of war; (2) procure, by purchase or gift, books of this kind in sufficient quantities, and arrange for their distribution through the Camps Library to the various organisations and corps; (3) draw up lists of such books required by, or suitable for, various types of men. An appeal is made for funds to carry on this work, and we trust that it will meet with a ready and generous response. Contributions should be forwarded to Dr. I. Gollancz, treasurer of the Fighting Forces Book Council, Seymour House, Waterloo Place, London, S.W., or to the London County and Westminster Bank, Law Courts Branch, W.C.

SOCIETIES AND ACADEMIES.

LONDON.

Aristotelian Society, January 3.—Dr. H. Wildon Carr, president, in the chair.—Prof. A. N. **Whitehead**: Space, time, and relativity. Mathematicians have succeeded in defining diverse Euclidean measure-systems without any reference to distance. There are alternative groups of such congruent transformations of space all equally applicable, but, while the distance P_1P_2 may equal the distance Q_1Q_2 for one measure-system, it

will not equal it for another. The extraordinary thing is that each of us does, as a matter of fact, employ a determinate measure-system which remains the same, except probably for very small variations, and that the measure-systems of different human beings agree, within the limits of our observations. This, however, is different in regard to time. Owing to the fact that points of space are incapable of direct recognition, there is a difficulty in determining what is at rest and what is in motion, and a further difficulty of determining a definite uniform flow of time. If all physical influences require time for their propagation in space, the idea of an immediate presentation to us of an aspect of the world as it in fact is must be abandoned. What we perceive at any instant must, in that case, already be ancient history, with the dates of the various parts hopelessly mixed. Again, if all physical influence is electro-magnetic, all influences are propagated with the velocity of light *in vacuo*. But what dynamical axes are we taking as at rest? There are two possibilities. We may assume either (*a*) that one set of axes are at rest and that the others will show traces of motion in respect to the velocity of light, or (*b*) that the velocity of light is the same in all directions whichever be the dynamicial axes assumed. The first supposition is negatived by experiment, and hence we are driven to the second, which immediately lands us in the whole theory of relativity.

Geological Society, January 5.—Dr. A. Smith Woodward, president, in the chair.—E. B. **Bailey**: The Islay anticline (Inner Hebrides). Other observations in regard to the "Schistose Islands" of Scotland are passed in review, and many of them confirmed. Certain new interpretations are offered. (1) An important fault, perhaps the Great Glen Fault, passes through the hollow separating Colonsay and the western peninsula of Islay from the rest of the archipelago. (2) The dolomitic "Fucoid Beds" are not the highest geological subdivision of the district. They are earlier than, and structurally they underlie, the greater part of the Islay Quartzite, as well as the whole of the Port Ellen Phyllites and Easdale Slates. (3) Several correlations must now be abandoned. Thus the Scarba Conglomerate is not the equivalent of the Portaskaig Conglomerate, but is of considerably later date. (4) Small-scale isoclinal folding is of less significance in the greater part of the district than has sometimes been thought. The main feature of the tectonics of eastern Islay is a comparatively simple isoclinal anticline overthrown towards the north-west upon the Loch Skerrols Thrust. (5) Finally, grounds are given for believing that an accurate knowledge of the structure and rock-succession of Islay is of crucial importance in determining the tectonic plan of the West Highlands generally.

PARIS.

Academy of Sciences, January 3.—M. C. Jordan in the chair.—G. **Bigourdan**: The manuscrips of the works of Jean de Lignières.—G. **Humbert**: Continued fractions and indefinite binary quadratic forms.—Paul **Appell**: The hidden relations and the apparent gyroscopic forces in non-holonomial systems.—Henry **Le Chatelier**: The laws of solution. A reply to M. Colson.—M. de **Sparre**: The projectory of projectiles shot with high initial velocity with an angle of projection in the neighbourhood of 45°.—Pierre **Delbet**: The action of antiseptics on pus. Experiments on the effects of antiseptics on pus *in vitro* gave unexpected results, as even after twenty-four hours' contact sterilisation was the exception. A 2 per cent. solution of carbolic acid was sterile in six cases out of fifteen; ether, corrosive sublimate, hydrogen peroxide, Dakin's solution, Labarraque's solution, were all less effective. —J. Comas **Solà**: Some astronomical applications of stereoscopic photography. Description of a special apparatus, the "stereogoniometer."—Pierre **Humbert**: The simplification of a formula of Liapounoff.—L. **Tschugaeff** and W. **Lebedinski**: A new series of platinum compounds analogous with Cossa's salts. Acetonitrile resembles ammonia and the organic amines in its reaction with soluble chloroplatinites.—Domingo de **Orueta** and S. Piña de **Rubies**: The presence of platinum in Spain. Between Malaga and Gibraltar, in the Ronda massif, there is a series of rocks strongly resembling the platiniferous rocks of the Urals. Borings made near Taguil gave proportions of platinum varying from traces to 28 grams per cubic metre, the average of fifty borings giving about 3 grams per cubic metre. On account of its importance, the matter has been taken up by the Spanish Government, with a view to the thorough investigation and ultimate exploitation of the deposit.—Emile **Saillard**: The attack of beetroot by *Cercospora beticola*.—Jules **Regnault**: A case of lateral thoracic cords, probable embryonic vestiges of Wolf's band in a man.—Paul **Godin**: The individual formula of physical growth for children of both sexes.—Maurice **Mendelssohn**: Galvanotaxy of the leucocytes. A description of changes of form and motion observed in leucocytes when acted upon by galvanic currents.—C. **Houlbert** and C. **Galaine**: The formation of shell partitions (*chambrage*) in oysters and the possible infection of these spaces by a parasitic Annelid of the shell.

BOOKS RECEIVED.

Board of Agriculture and Fisheries. Fishery Investigations. Series II.—Sea Fisheries. Vol. ii., No. 3. Pp. 31. Vol. iii., No. 1. Pp. 46. (London: H.M.S.O.; Wyman and Sons, Ltd.) 2*s*. and 3*s*. respectively.

An Inquiry into the Statistics of Deaths from Violence and Unnatural Causes in the United Kingdom. By Dr. W. A. Brend. Pp. v+80. (London: C. Griffin and Co., Ltd.) 3*s*. 6*d*. net.

A Student's Heat. By I. B. Hart. Pp. vii+376. (London: J. M. Dent and Sons, Ltd.) 4*s*. 6*d*.

Applied Mechanics, First Year. By H. Aughtie. Pp. 184. (London: G. Routledge and Sons, Ltd.) 2*s*. net.

Textile Mechanics. By W. Scott Taggart. Pp. vii+117. (London: G. Routledge and Sons, Ltd.) 2*s*. net.

Proceedings of the London Mathematical Society. Second Series. Vol. 14. Pp. xxxviii+480. (London: F. Hodgson.)

Elementary Applied Mechanics. By Profs. T. Alexander and A. W. Thomson. Third edition. Pp. xx+512. (London: Macmillan and Co., Ltd.) 15*s*. net.

An Outline of Industrial History, with special reference to Problems of the Present Day. By E. Cressy. Pp. xiv+364. (London: Macmillan and Co., Ltd.) 3*s*. 6*d*.

Macmillan's Geographical Exercise Books. Key to I.—The British Isles. With Questions by B. C. Wallis. Pp. 48. (London: Macmillan and Co., Ltd.) 2*s*. 6*d*. net.

Willing's Press Guide, and Advertiser's Directory and Handbook, 1916. Pp. 472. (London: J. Willing, Ltd.) 1*s*.

Canada. Department of Mines. Geological Survey. Memoir 50: Upper White River District, Yukon. By D. D. Cairnes. Pp. iv+191. Memoir 60: Arisaig—Antigonish District, Nova Scotia. By M. Y. Williams. Pp. vi+173. Memoir 81: The Oil and Gas Fields of Ontario and Quebec. By W. Malcolm. Pp. ii+248. (Ottawa: Government Printing Bureau.)

Engineering Geology. By Profs. H. Ries and T. L. Watson. Second edition. Pp. xxvii+722. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 17*s.* net.

Mathematical Tables for Class-room Use. By M. Merriman. Pp. 67. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 2*s.* 6*d.* net.

Decorative Design. By J. C. Chase. Pp. vi+73. (New York: J. Wiley and Sons, Inc.; London: Chapand Hall, Ltd.) 6*s.* 6*d.* net.

A Plea for an Orderly Almanac By A. Philip. Pp. 62. (Brechin: D. H. Edwards.) 1*s.* net.

Report on the Operations of the Department of Agriculture, Madras Presidency, for the Official Year 1914–15. Pp. 56. (Madras: Government Press.)

Meteorological Office. British Meteorological and Magnetic Year Book, 1913. Part iv., Section 2. Hourly Values from Autographic Records: Geophysical Section, 1913. Pp. 97. (Edinburgh: H.M.S.O.; London: Meteorological Office.) 5*s.*

Egyptian Government. Almanac for the Year 1916. Pp. viii+248. (Cairo: Government Press.)

Problems in the Calculus with Formulas and Suggestions. By Dr. D. D. Leib. Pp. xi+224. (Boston and London: Ginn and Co.) 4*s.* 6*d.*

The Apple: a Practical Treatise dealing with the latest Modern Practices of Apple Culture. By A. E. Wilkinson. Pp. xii+492. (Boston and London: Ginn and Co.) 8*s.* 6*d.*

The Mechanism of Mendelian Heredity. By Prof. T. H. Morgan, A. H. Sturtevant, H. J. Muller, and C. B. Bridges. Pp. xiii+262. (London: Constable and Co., Ltd.) 12*s.* net.

Aircraft in Warfare: the Dawn of the Fourth Arm. By F. W. Lanchester. Pp. xviii+222. (London: Constable and Co., Ltd.) 12*s.* 6*d.* net.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 20.

ROYAL INSTITUTION, at 3.—The Utilisation of Energy rom Coal: The Chemistry and Economics of Coal and its By-Products: Prof. W. A. Bone.

LINNEAN SOCIETY, at 5.—The Definition of "Right" and "Left" in relation to Coiled, Rolled, Revolving, and Similar Objects: a Problem in Scientific Terminology: Miller Christy.—Some Aspects of the Bagshot Sands Flora: H. W. Monckton.—Colour-photographs of Mollusca: B. B. Woodward.

ROYAL GEOGRAPHICAL SOCIETY, at 5.—The Middle Tees and its Tributaries: C. B. Fawcett.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Principles of Modern Printing Telegraphy: H. H. Harrison.

INSTITUTION OF MINING AND METALLURGY, at 5.30.—Chinese Mining Legislation: W. F. Collins.—Taylor's Pulp Sampler: W. H. Trewartha-James.

FRIDAY, JANUARY 21.

ROYAL INSTITUTION, at 5.30.—Problems in Capillarity: Sir James Dewar.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—The Flow of Air through Nozzles: Capt. T. B. Morley.

MONDAY, JANUARY 24.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Cyrenaica: Prof. J. W. Gregory.

TUESDAY, JANUARY 25.

ROYAL INSTITUTION, at 3.—The Physiology of Anger and Fear: Prof. C. S. Sherrington.

INSTITUTION OF CIVIL ENGINEERS, at 5.30.—*Discussion*: The Electric Locomotive: F. W. Carter.

WEDNESDAY, JANUARY 26.

ROYAL SOCIETY OF ARTS, at 4.30.—The Effect of the War on Cotton Growing in the British Empire: J. A. Hutton.

THURSDAY, JANUARY 27.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: The Theory of the Helmholtz Resonator: Lord Rayleigh.—A Collision Predictor: Prof. J. Joly.—Discussion of Kew Magnetic Data, especially the Diurnal Irregularities of Horizontal Force and Vertical Force, from ordinary days of the eleven years 1890 to 1900: Dr. C. Chree.—A Portable Variometer for Magnetic Surveying: G. W. Walker.—The Single Line Spectrum of Magnesium and other Metals and their Ionising Potentials: Prof. J. C. McLennan.—The Microscopic Structure of Semipermeable Membranes, and the Part Played by Surface Forces in Osmosis: F. Tinker.—The Reduction of Metallic Oxides with Hydrogen at High Pressures: E. Newbery and J. N. Pring.—Discontinuous Fluid Motion Past a Curved Boundary: H. Levy.

ROYAL INSTITUTION, at 3.—Fuel Economy from a National Standpoint: Prof. W. A. Bone.

FRIDAY, JANUARY 28.

ROYAL INSTITUTION, at 5.30.—The Science of Clothing and the Prevention of Trench Feet: Dr. Leonard Hill.

PHYSICAL SOCIETY, at 5.—Guthrie Lecture: Some Problems of Living Matter: W. B. Hardy.

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THURSDAY, JANUARY 27, 1916.

GERMANY'S AIMS AND METHODS.

IN the debate on January 10 on Mr. Hewins's motion that Britain should co-operate in the closest manner with her colonies in prosecuting the war, he pointed out that the Germans do not separate their military from their commercial policy. "From the German point of view, the war began some years ago in certain economic measures, and the war will continue after the conclusion of military operations in certain economic measures which they already have in preparation." This is profoundly true, and some of the details of these economic operations are very clearly put by Mr. Hewins in his speech. He went on to point out that the present hope of Germany is not so much a complete military victory, as a position from which they will be able "to foist upon conquered territories German contracts, German aims, and German traditions." He does not think that a customs-union with the Dominions and the Allies is a possible method of opposing Germany, but counsels control of raw materials produced in the Empire, so that they may never again come into German hands. The question of shipping, too, should be an imperial one; also that of treaties. There must be a spirit of solidarity among the Allies in any treaties with Germany which may in future be made. The writer agrees; but ventures to think that a refusal to make any treaty whatever with Germany and her allies would be a better measure.

The seconder of the resolution, Mr. Peto, discussed the question of shipping more fully, and dissented from the present Government policy of keeping all knowledge of our intentions from the Germans. If they knew that German shipping would in future be placed under rigorous control, that would be bound to influence their conduct of the war.

Sir Alfred Mond feared that the policy sketched by the two previous speakers would damage our own trade. Moreover, he dissented from Mr. Hewins's view that the present war was being waged in support of an economic policy; he attributed it to racial and imperialistic, and not to commercial motives, and said that to his knowledge Germany and her allies had confused notions of what they were fighting for. He attributed German success to their scientific and technical skill, and to the influence of their banking system. He regarded the United States as likely to be a more formidable trade rival than the Germanic nations.

Mr. Shirley Benn advocated a return to the old navigation laws, and Mr. Prothero thought that a joint system of credit with our Dominions would have a great influence in countering German aggression. Mr. Chaplin counselled joint action with the Dominions in imposing a tariff against the entry of German goods. Mr. Mackinder welcomed the attitude of Sir Alfred Mond towards a tariff, and suggested that we might at once utilise a large sum belonging to Germany, which we hold, and which might be used for the production of materials necessary to our country at the present moment. He pointed out that Germany is organising the territory which she has conquered to help her in the war with materials, and he counselled that we too should organise. There are necessary materials which demand the expenditure of money on plant; manufacturers are unwilling to risk capital on business which may come to an end with the war, and require a guarantee that the Empire should stand by them and assure them against loss. Mr. Pennefather pointed out that while the Teutonic nations have only some 18 per cent. of the world's trade, the Allies control 50 per cent., and strongly pressed for an economic union with our Dominions.

Some of Mr. Runciman's remarks were reproduced in NATURE of January 13; he recommended improvement of research methods, the education of our people, and the training of our young men. The main points in his speech were the shortage of food in Germany, from which he drew comfort. His attitude of mind was shown by his hope for the recuperation of Germany, as well as of the other belligerent Powers; and here Mr. Runciman showed his complete failure to grasp the situation. The fact is that the Allies do not wish Germany to recuperate. Recuperation means power to intrigue, to use all means to prosecute an economic warfare, and to conquer other nations and destroy their trade. It is lamentable to find the head of a great Government department so blind to present conditions, and so unable to forecast the future. He fears that the suppression of Germany would entail suffering on the Allies; perhaps it might; but the waging of the present war entails suffering on the Allies, and yet no one proposes to sue Germany for peace. Mr. Runciman then dealt most unsatisfactorily with the question of contraband. Had it not been for his opposition and that of the Board of Trade, had the Admiralty been granted full control, we should not have seen those

departments obliged to climb down, only in consequence of the expression of an irresistible public opinion, and doing "too late" what should have been done at the beginning of the war. We have been guilty of incredible folly in allowing a man to retain a position of enormous influence who, by his sayings before the outbreak of war, showed himself totally unfit to deal with the situation as it manifested itself in August, 1914. Towards the end of his speech he said, "A man would indeed have to be blind if he could not see the fact that commercially Germany is a beaten nation." Well, no German thinks so, and it is the supremest of blunders to assume it. It may conceivably be true; but if it is, it is no business of ours to act as if we thought so. Indeed, the debate has had the virtue of inducing Mr. Runciman to reveal his entire incompetency for the position which he holds.

Mr. Bigland brought forward specific instances of German methods of capturing trade, and urged the adoption of a definite protective policy on the part of the Empire and the Allies; and Sir John Rees advocated the inclusion of India and Ceylon. Sir John Spear, representing an agricultural community, and Mr. Montague Barlow, speaking for an industrial community, supported Mr. Hewins's motion. The latter described how the Germans captured the wolframite supply of Cornwall, owing to State subsidies, cutting down the price from 5*s*. 6*d*. to 2*s*. 6*d*., and killing an English company with a capital of 20,000*l*. Having secured a monopoly, they raised the price to 7*s*. 6*d*.! It would be well if instances like this were collected and published, so that the public might know the extent of previous German aggression. Mr. Barlow also described the effects which German banking credits have on their industry. Mr. Fell doubted whether a boycott of German goods could possibly be permanent, and in this the writer agrees. Goods of German origin would certainly enter England from neutral countries, and it would be impossible to exclude them.

Mr. Lynch gave a sketch of Wilhelm von Humboldt's work in organising German education in 1809, and described German methods of trade aggression. He imputed the capture of many British industries to the educational policy of the Germans, especially on technical lines, and related his experience at the hands of the Government "pundits" when he applied for the modest sum of 10,000*l*. for the encouragement of research. This speech concluded the debate.

It is indeed time for drastic reform in most of our Government departments. It has been frequently pointed out that the prominence given to classics, and the under-estimation of science in Civil Service examinations, has resulted in the staffing of our Government offices with men, not only absolutely ignorant of science, but incapable of appreciating scientific advice when it is tendered. It would be a breach of confidence were the writer to tell of the appalling "howlers" enunciated in his presence by those in high places. Whereas very few men of science are entirely ignorant of the spirit inculcated by a study of the classics, while they can at least appreciate the attitude of mind of the cultured classicist, those who have been educated solely on classical lines in our public schools and universities are quite incapable of taking the point of view of men who have been trained scientifically or commercially. Precedent, and precedent alone, rules the minds of the classicist; the scientific man demands proof, and has small respect for precedent. Nor are our classically trained heads of departments able to form a useful opinion on recommendations pressed on them by scientific advisers. They have not the training required; nor can they acquire the mental attitude. The writer has in mind a law-suit in which an eminent judge spent three weeks in learning his lesson; barristers versed in science stated the case to him, and he himself cross-examined competent scientific experts. In my view, his decision was a just one. In the Court of Appeal the judges were unqualified to re-judge the case, for they had not had the benefit of three weeks' instruction; they reversed the first judgment. And the House of Lords, on further appeal, had not the glimmering of an idea of the scientific principles which had influenced the judge of first instance in making up his mind, and injustice was done when they upheld the verdict of the Court of Appeal. But the just decision of the first judge showed that with willing intelligence, time, and sufficient instruction a man can educate himself to form a correct opinion on an abstruse scientific point.

Now the head of a Government department has not the training, nor can he afford the time to understand scientific arguments which may be brought before him; he therefore "makes a shot," influenced by expediency and by an inclination to take a course which will least commit him, needless to say, usually with disastrous results.

Reform of the Civil Service examinations would doubtless remedy this dangerous state of affairs, but it will take a generation to do it. And immediate action is called for. Take the Board of Trade as an example. There *is* a Board of Trade;

it consists of Mr. Runciman, the President, of his Grace the Archbishop of Canterbury, of the Speaker of the House of Commons, and of the *Speaker of the Irish House of Commons.* On the 20th inst., Mr. Lynch asked the President whether it would not be desirable "to reconstitute the Board so that it may contain two men of recognised ability in the industrial world, and two men of science, noted for their knowledge of technical education and interested in the problem of providing for its application to industrial development?" Mr. Pretyman said there were grave objections to any scheme which would divide the responsibility of the President among the members of a board, and that the object was attained by the development of advisory committees of experts whom the President can consult. But what if you have a President unable to understand their recommendations? We have only to remember the ghastly blunder committed at the beginning of the war in the non-recognition that cotton and fats are potential ammunition. We cannot afford to make any more blunders, and it is a good maxim that when a man has blundered once, he should not have any further chance of endangering the Empire. This is a time for drastic action; how can it be achieved? Can our Dominions exert pressure? There is no means by which public opinion can manifest itself except by a general election, and that is denied us. But time is passing, and the enemy is gaining ground. Must we still "wait and see"?

WILLIAM RAMSAY.

PHYSICS FOR ENGINEERING STUDENTS.

(1) *Introduction to Magnetism and Electricity.* By E. W. E. Kempson. Pp. viii+240. (London: Edward Arnold, 1915.) Price 3*s.*

(2) *A First Course in Engineering Science.* By P. J. Haler and A. H. Stuart. Pp. viii+191. (London: University Tutorial Press, Ltd., 1915.) Price 2*s.* 6*d.*

(3) *Practical Shop Mechanics and Mathematics.* By J. F. Johnson. Pp. ix+130. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1915.) Price 4*s.* 6*d.* net.

(4) *Continuous and Alternating Current Machinery Problems.* By Prof. W. T. Ryan. Pp. vii+37. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1915.) Price 2*s.* 6*d.* net.

(1) MR. KEMPSON'S book on magnetism and electricity is based on the course given to the science forms in the Upper School at Rugby. The ground covered is fairly extensive, and the matter is dealt with more from the experimental side than the mathematical. The phenomena of induced currents, however, are not touched. Part of the author's aim in writing the book has been to bring out clearly the connecting link between static and current electricity. He contends that the impression left on the average pupil after perusal of most text-books is that static and current electricity are separate and distinct phenomena. The only link usually attempted is the experiment with the voltaic cell and condensing electroscope. In our opinion, the chief advantage of the old method is cheapness; the method suggested by the author necessitates the provision of much more expensive apparatus than is usually found in school laboratories, viz., electrostatic voltmeters and condensers.

The author states in his preface that the relatively large and varying capacity of static voltmeters is likely to give trouble if not borne in mind. We entirely agree, and would add that it is scarcely possible for the pupil at this stage to follow the method by which the teacher calculates size of condensers, speed of rotating commutators, etc., necessary to ensure success of the experiments suggested. In the section on magnetism, p. 11, we should prefer a more precise definition of unit magnetic pole; the medium in which the poles are placed should be stated; and we object to the words in brackets in the same paragraph, thus: "1 dyne (1/981 of a gramme's weight)." The book is provided with a large selection of numerical exercises to which answers are supplied. The student working through this book will have familiarised himself with many electrical testing instruments.

(2) Haler and Stuart's "First Course in Engineering Science" covers the ground suggested by the Board of Education in its "Memorandum on the Teaching of Engineering in Evening Technical Schools." The book is divided into two parts. Part i. deals with measuring instruments, experimental mechanics, and the testing of materials. Simple experiments are described illustrating the principles, and the apparatus needed is such as can be easily constructed in the school workshop. The text is illustrated by a good selection of clear diagrams, and each chapter is provided with a set of numerical exercises. The second part of the book is devoted to the elementary principles of heat, and includes chapters on the steam engine, indicator diagram, and the use of steam tables. On p. 118 there is an error in the formula given for the expansion coefficient of a liquid by the specific gravity bottle; the quantity in the denominator should be the weight of liquid filling the bottle at the higher tempera-

ture. The experiment on p. 135, "to find the temperature of a furnace," is misleading. A piece of nickel is placed in the furnace and then transferred to a calorimeter containing water, the rise of temperature being noted. At 1000° C. the specific heat of nickel differs very considerably from the value at the ordinary temperature. On p. 163 the authors cite the boiling of water in a paper vessel as an effect similar to that obtaining in a boiler plate. In a boiler plate of good conducting material there is, of course, little difference of temperature between the two sides, but paper is a bad conductor of heat, and the reason the paper does not burn is due to an entirely different cause. When water is boiled in a paper vessel the escape of vapour through the paper is considerable, and the flame is usually quite ½ in. from the paper.

(3) Mr. Johnson's book is written for the ambitious artisan, and is based upon notes made by the author during nine years' teaching experience in evening vocational and technical schools in the United States. For its perusal no further mathematical knowledge is required than the elementary rules of arithmetic, simple equations, and the trigonometrical ratios of an angle. It includes chapters on engineering measuring instruments, calculations of areas and weights, pulleys and belting, gearing, properties and strength of materials. Two chapters dealing with the elements of statics are fully illustrated by practical examples from the workshop. The book is clearly written and the diagrams are well executed. A large number of numerical exercises are interspersed in the text, but the workman bent on self-improvement would find the book of considerably greater value if the author had furnished answers to these examples.

(4) The collection of problems by Prof. Ryan (upwards of one hundred) is intended to be used with Morecroft's elementary text-book on "Continuous and Alternating Current Machinery." No answers are provided.

METALLURGY OF GOLD.

The Metallurgy of Gold. By Sir T. K. Rose. Sixth edition. Pp. xix+601. (London: C. Griffin and Co., Ltd., 1915.) Price 22*s.* 6*d.* net.

SIR THOMAS ROSE'S "Metallurgy of Gold" has been recognised for the last twenty years as the best general treatise on the metallurgy of the metal; the appearance of this new edition, which by revision and expansion is practically a new book, will hence be warmly welcomed by all metallurgists. Since the last edition was published in 1906 the changes which have been introduced in the metallurgy of gold have been greater than those in any other metal; the need for a new edition of the book was therefore imperative, and this need has been admirably satisfied in the present volume.

As stated in the preface, "the most important function which a book on metallurgy has to fulfil is to help those who are taking part in attempts to improve existing practice," and with that aim in view the whole book has been thoroughly revised and much new matter added. The early chapters, which have been rewritten and greatly enlarged, now contain a remarkably full and accurate account of the properties of gold, its compounds and alloys, and throughout the volume special attention is given to the principles underlying the various practical operations involved in the extraction of the metal, and in the refining and preparation of gold bullion for the market and for minting. In this connection it will be admitted by all that without a knowledge and clear understanding of these properties and principles, an acquaintance with mere practical details, however extensive, will not be sufficient to enable the metallurgist to cope successfully with the difficult problems which will confront him from time to time in the practical operations of the metallurgy of gold.

The remarkable success which during recent years has attended the introduction of the filtration of slime on the vacuum principle has led to a complete change in the functions of the stamp battery as a crushing machine; the chapters dealing with stamps, crushing, fine grinding, and amalgamating machinery have hence been largely rewritten and brought thoroughly up to date.

But it is in the cyanide process that we find the most conspicuous changes and advances, hence the chapters devoted to it are for the most part new. These chapters contain an authoritative account of the various mechanical developments of the process of the principles involved in working it, and of the latest and most approved practice in modern cyanide works. Detailed descriptions are given of the plant and appliances in current practice for the treatment of sand, and of the various agitators, vacuum filters, filter presses, &c., employed in the treatment of slime. Further, the reactions which take place in the cyanide process, the conditions necessary for the success of the various operations, and the best means of carrying them out, from the crushing of the ore to obtaining the gold as bullion, are all given clearly and concisely. In chapter xvii. modern practice is exemplified by the operations at typical plants. These chapters contain, in fact,

an account of the process of the greatest value to those practically engaged in cyaniding, and also to students.

The author's chapter on the electrolytic parting of gold and silver, which bids fair to displace the old methods of treatment with sulphuric or nitric acids, is one of the most important in the book. It is not only an excellent *résumé* of the practice followed, but also embraces the valuable experimental work done by the author himself.

Of the chapters on the assay of gold ore and bullion it need only be said that they are worthy of the assayer of the Royal Mint.

Much care has been taken, as in previous editions, in quoting the sources of the information given throughout the book, and the wealth of references in the footnotes is a valuable bibliography of the literature of the subject.

We unreservedly commend the book as being indispensable, not only to students, but also, and especially, to all who are practically engaged in the metallurgy of gold. W. GOWLAND.

PSYCHICAL RESEARCH.

Apparitions and Thought-Transference: An Examination of the Evidence for Telepathy. By F. Podmore. New and enlarged edition. Pp. xviii + 467. (London: The Walter Scott Publishing Co., Ltd., 1915.) Price 6*s*.

THIS is a new edition, in the Contemporary Science series, of a book which still remains, after twenty-one years from its first appearance, one of the best introductions to the subject (see review in NATURE, December 6, 1894). The illustrative cases have now inevitably a rather ancient history appearance, and many of them are duplicated in other books, such as Myers's "Human Personality" and Sir Oliver Lodge's "Survival of Man"; it may be urged, therefore, that an entirely fresh treatment of the subject, with due attention to the experiments of Miss Miles and Miss Ramsden and to the S.P.R. cross-correspondences, would have been preferable to a *rechauffé*. Moreover, the author being dead, various slips occur: the American S.P.R. is no longer a branch of the English society; the latter's publisher is now the firm of Maclehose, not R. Brimley Johnson; Dr. Sidis's name is wrongly spelt on p. 260, as Sir Joseph Barnby's is in the index; and there is an inventive misprint of "Boding" for "Bodily" on p. 459, in the reference to Myers's "Human Personality." But these are not very important matters.

Mr. Podmore's thesis is that communication is possible between mind and mind otherwise than through the known channels of the senses. Beginning with the early mesmerists, who in some cases seem to have hypnotised patients at a distance, he proceeds to cases of transference of pain or of visual images, in the experiments of Dr. Liébeault and the Nancy school generally, and of Prof. and Mrs. Sidgwick and Sir Oliver Lodge; thence to spontaneous cases in dream or hallucination, culled largely from the monumental collection, "Phantasms of the Living," which is now out of print. Possible sources of error are carefully considered and allowed for, and the author's conclusion is—quoting Prof. De Morgan—that either the thesis as above stated is a justified hypothesis, or we must say at leisure what David is reported to have said in his haste. And if the latter—if human testimony is completely untrustworthy—there is an end of history and various other sciences.

It is a somewhat remarkable fact, considering the newness and difficulty of the research, that the opinions expressed in the book would call for little alteration, after twenty-one years, if they were to be revised by a committee representative of the present leaders of the S.P.R. Probably their only qualifying remark would be that it is not quite as certain as Mr. Podmore thought that such phenomena as Mrs. Piper's are completely and truly explained by telepathy. Other hypotheses, more far-reaching but not less essentially scientific if we can free our minds from prejudice, are possible.

Finally, we may remark that the present war presents a scientifically good if morally regrettable opportunity of making exceptional records in psychical research. There is reason to believe that a moment of stress, of great excitement or emotion or concentration, is favourable to the initiation of a telepathic impulse. It is probable that many people at home have become aware of their soldier-relative's wound before the news arrived by normal means. A dream or hallucination may show the nature of the wound, as in Mr. Colt's case in "Human Personality." These experiences should be at once recorded; and if the percipient will send the account, before verification, to the S.P.R., 20 Hanover Square, W., he or she may be assured of sympathetic interest and may be furnishing useful data. Obviously, expectation will account for some of these experiences; but when there is much true detail other suppositions may become necessary. J. A. H.

OUR BOOKSHELF.

Penrose's Annual, 1916. Vol. xxi. *The Process Year Book.* Edited by W. Gamble. Pp. 112 + illustrations. (London: Percy Lund, Humphries and Co., Ltd., 1916.) Price 5*s*. net.

IN taking up an annual that deals with the progress of a handicraft at such a time as this, one naturally looks for the effects of the unprecedented conditions that now afflict us. On the

face of it there is little evidence of adversity. The volume is well produced, the articles are interesting and hopeful, and the illustrations, which show what photo-mechanical work in its many branches is capable of, are numerous and excellent. But the editorial *résumé* of the year's progress gives us a truer idea as to how matters really stand. We learn that colour work is under a cloud because of a reduced demand, and the working of it suffers much from the shortage of collodion, and the difficulty of getting dyes for sensitising plates and for the preparation of inks.

In line and half-tone work there is nothing new except that the demand for high-class blocks has much diminished, and with it the consumption of copper, while zinc is about four times the price it was; and so on to other branches of work. But rotary photogravure, that is, photogravure as adapted to rapid machine printing, has been taxed to its utmost in the production of publications illustrating the progress of the war. Even in Paris, where we are apt to think that all business is at a standstill, "a large amount of really excellent work is being done."

It is also developing rapidly in Spain, Sweden, Holland, Russia, Switzerland, Canada, and the United States. Perhaps the most pleasing aspect of the Annual is the evidence it contains of a confident hope that after the war there will be a great industrial revival, and that it is now being duly prepared for, while even at present matters are far from being as bad as one might have expected.

Stars of the Southern Skies. By M. A. Orr (Mrs. John Evershed). Pp. xii+92. (London: Longmans, Green and Co., 1915.) Price 2s. net.

THIS little book is apparently intended as a companion to a star atlas for the use of those who have only small instrumental means for observation or no instruments at all. Although it refers almost exclusively in detail to the more remarkable objects of the southern hemisphere, the author has managed to interweave a good deal of interesting information which is applicable to the stars in general. The book opens with a brief account of the southern constellations, accompanied by a simple map, and this is followed by a series of chapters dealing with such subjects as "the ten brightest stars," "eclipsing stars," "star clusters," and "the clouds of Magellan." The descriptions of the various objects are notable for the numerous references to the results obtained by the use of the spectroscope, and in this connection it would have been an improvement to include either a photograph or a diagram illustrating the chief types of stellar spectra. A more generous supply of illustrations would also have been advantageous in other respects. Apart from this, the book will doubtless be welcomed by many readers, being brightly written and the facts well up-to-date. Those who have learned to recognise the stars, and have no special knowledge of astronomy, will find here just that little additional information which will help to maintain an intelligent interest in the wonders of the heavens.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Pre-Columbian Representations of the Elephant in America.

I NOTE with no little interest that the subject of "the elephant in America" has been revived in a communication to NATURE by Prof. G. Elliot Smith. The animal pictured by Prof. Smith has been interpreted by Dr. Allen and myself as a blue macaw (*Ara militaris*) in the following passage:—"The (figure) has even been interpreted as a trunk of an elephant or a mastodon, but is unquestionably a macaw's beak. In addition to the ornamental cross-hatching on the beak, which is also seen on the glyph from the same stela, there is an ornamental scroll beneath the eye, which likewise is cross-hatched and surrounded by a ring of subcircular marks that continue to the base of the beak. The nostril is the large oval marking directly in front of the eye" (Tozzer and Allen, Peabody Museum Papers, vol. iv., No. 3, p. 343, Cambridge, 1910).

If Prof. Smith will look on the back of the monument on which his figure is found (Maudslay, vol. i., pl. 38), he will note at the bottom the drawing of the glyph referred to in the quotation. This is unmistakably a macaw. A comparison of this with the "elephant" shows that the two represent the same animal. Other drawings of the same bird may be seen in Maudslay, vol. i., pl. 93, glyphs 10, 25, 28, and pl. 112a, glyph 12.

The two drawings in Bancroft to which Prof. Smith refers lose their significance as "elephants" when one examines the photographs of the originals from which these early and crude drawings were taken. The first (Maudslay, vol. iv., pl. 35) is the "long-nosed god," called by Schellas, "God B." The second is the projecting nose of a grotesque mask, one of the most common features in the decoration of the buildings in Yucatan. Other references to elephants which are given are the "elephant mound" of Wisconsin and the "elephant pipes" of Iowa. The first has been found to represent, in all probability, a bear. The projection called the trunk does not belong to the original earthwork, but is due to an accumulation of sand. The "elephant pipes" have long been accepted as forgeries by all competent archæologists who have examined them.

ALFRED M. TOZZER.

Peabody Museum, Harvard University.
Cambridge, Massachusetts, December 15, 1915.

IF a note from across the sea is not so delayed as to be no longer timely, may I reply to Dr. G. Elliot Smith's remarkable communication on pre-Columbian representations of the elephant in America in NATURE of November 25? The identification of the details on Stela B at Copan as elephants is neither new nor unanswered, and the same may be said of the extension of this identification to the conventional faces with outward curving noses that decorate the buildings of northern Yucatan.

Of course, there is a tremendous weight of improbability to be counted against such an identification, and the suggestion that these heads may represent tapirs would seem more reasonable, since this animal is a native of Central America, while the elephant is not. But in making either guess we should have failed to take account of the peculiarities of Maya art.

There appears to be little doubt that the heads under discussion on Stela B at Copan are intended to represent the blue macaw, while those on the buildings of northern Yucatan are but manifestations of the serpent that gives its proper character to Maya art. These somewhat ludicrous extremes in identification are reached by comparison with other Maya representations rather than by comparison with drawings made in China. In the first instance, it was arrived at independently by F. Parry in his "Sacred Maya Stone," a fanciful study written in 1893; by G. B. Gorden in "Conventionalism and Realism in Maya Art at Copan," 1909; by A. M. Tozzer and G. Allen in their "Animal Figures in Maya Codices," 1910; and by the present writer in his "Study of Maya Art," 1913.

Three drawings will serve to illustrate the point, all taken from Copan, and one from the back of Stela B itself. The first (*a*) is a full, round sculpture of a macaw head, in which the characteristic long upper bill, short under bill, and thick tongue are drawn rather realistically. The eye is surrounded by raised knobs, and below the eye there is a spiral

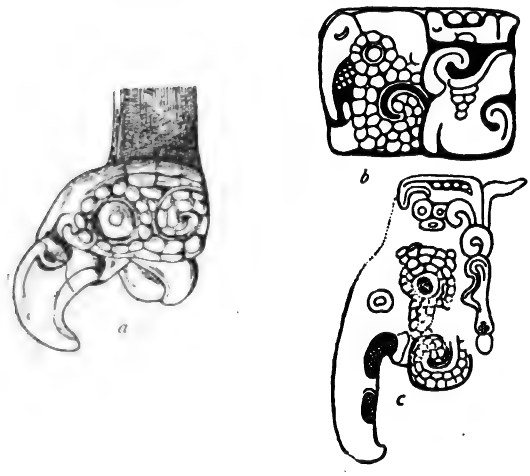

FIG. 1

formed by knobs. The nostril is seen in its proper position, and a line of demarcation appears along the lower edge of the upper bill. In (*b*) the left-hand half of the hieroglyph represents the same head, and it is to be noted that the under part of the upper bill is now differentiated from the upper part by cross-hatching When we come to *c* (the drawing is taken from the side, and shows details not visible on the front) we can trace all the parts shown in the two previous faces. The eye is surrounded by knobs, but the spiral below the eye is turned in the opposite direction. The nostril is in plain view, and parts of the under side of the upper bill are marked by cross-hatching. The lower bill and the tongue are lacking, but the omission of the lower jaw is very frequent in Maya drawings of animal heads. There is added, however, an ear, above which rises a flamboyant ornament. This detail of the ear with its ornament is unnatural, but is found, nevertheless, on most Maya drawings of reptile and bird heads. The Central American artists were not concerned only with the realism of natural motives, but having put in their drawing enough fact to identify the subject, they felt free to let their fancy range. Dr. Seler was not so absurdly mistaken as might be supposed in his suggestion of tortoise heads, because the Maya draw the head of this reptile very much as they do those of the macaw. The glyph for the day Kayab is now admitted to represent a bird's head, although previously explained as that of a tortoise.

That the heads with projecting snouts used as architectural decoration are connected with the concept of the snake rather than the elephant is easily proven by a study of homologous parts in a series of designs. Space forbids me to go into this subject, but I have already treated it rather fully in the paper referred to. As for the elephant-mound and the numerous "elephant-pipes," they have long since been discredited as regards the original identification, and not a few have been cast into the limbo of plain frauds.

It is not a mere difference of opinion upon rather minor details of archæology that prompts this reply to Dr. G. Elliot Smith's communication. It is because he ventures to draw conclusions of great importance as regards cultural connection between China and Mexico in ancient times from this tainted evidence. In dealing with the hydra-headed fallacy of Old World origins for New World civilisations it is necessary to cut off each head in turn with a searing sword. HERBERT J. SPINDEN.

American Museum of Natural History,
December 18, 1915.

IN my second letter on this subject, which was published in NATURE on December 16 (p. 425), I have already dealt with the main point raised by Prof. Tozzer's letter; and since then I have presented to the Manchester Literary and Philosophical Society, for publication in its Memoirs, a detailed examination of the whole problem, with a series of illustrations and a full discussion of all the evidence. The account given in my memoir sheds a remarkable light upon the psychology of Americans, both ancient and modern, and especially upon the ethnological "Monroe doctrine," which demands that everything American belongs to America, and must have been wholly invented there. The Maya civilisation was American in origin only in the same sense that Harvard University is—immigrants from the Old World supplied the ideas and the technical knowledge, which enabled an institution to be built up, no doubt with certain modifications prompted by local conditions and the contact of a variety of cultural influences.

FIG. 2.

As it may be some time before my lengthy memoir can be published, I should like to refer to Prof. Tozzer's other arguments now.

Like the other American ethnologists, to whom I referred in my last letter, he lays great stress upon the fact that "the ornamental scroll beneath the eye" (see the figures taken from Spinden's monograph) is found both in the elephant- (*c*) and the macaw-sculptures (*a*) at Copan; and he uses that fact as an argument in favour of what I regard as the picture of an elephant having been intended for a macaw. Has it ever occurred to Prof. Tozzer to inquire into the origin and meaning of the scroll to which he attaches so much importance? If he will do so, he will learn that, so far from the elephant having borrowed the scroll from the macaw, the scroll was an essential part of the elephant-design before it left Asia, and, in fact, is found in conventionalised drawings of the elephant in the Old World from Cambodia to Scotland. There is no doubt whatever that there was a certain amount of confusion in

the mind of the ancient American sculptor between the pictures of the elephant (*b* and *c*) and that of the macaw (*a*). Thus he provided the modern American ethnologist with an additional argument for refusing to admit that the sculptures *b* and *c*, as well as that which I reproduced in NATURE of November 25, and now repeat (Fig. 2), cannot have been intended for anything else than an elephant. Never having seen an elephant, and not being aware of its size, no doubt the Maya artist conceived it to be some kind of monstrous macaw; and his portraits of the two creatures mutually influenced one another. The geometrical pattern around the macaw's eye is an excellent conventialisation of the peculiar marking of the Central American macaw (Fig. 3): the pale area surrounding its eye occupies approximately an area relatively corresponding to the Indian elephant's pinna. The ear-ring often depicted (in Indian drawings) over the auditory meatus gives it an eye-like appearance. Is it any wonder, then, that the Maya artist should have taken the elephant's meatus (in a picture) for its eye, and have confused its pinna with the pale area on the macaw's head? Therefore, it was a natural thing to use the same convention for representing it as he had done in the case of the macaw. But the macaw's scroll was derived from the elephant-design. These and several other considerations, when the facts are set forth and examined in detail, as I have done in my memoir, make every stage in the history of the confusion so transparently clear that one can reconstruct the psychology of it with the utmost confidence. It is equally certain that the scroll below the ear, as well as the tree-like appendages above the head (shown in Fig. 1, *c*), are parts of the conventional waves breaking around the sea-elephant type of the Indian "Makara," which was the commonest form of the elephant spread abroad by the seamen of southern India, whence the great migrations started. This is admirably demonstrated also in the Scotch and Scandinavian pictures of elephants.

FIG. 3.—The Central American Macaw.

The Copan sculptor has provided the elephant with a new ear (Fig. 1, *c*), also modelled on the Makara's ear, and provided with a characteristically Cambodian pendant. If *c* was meant to be a macaw, why was it given a mammalian ear?

It is significant that the American ethnologists who entertain the macaw-hypothesis do not refer to the perfect example, which I have used (Fig. 2), but only to the cruder, damaged remains of the other Copan elephant (Fig. 1, *c*), in which the compromising turbaned-rider and his elephant-goad, as well as the distinctive profile of the Indian elephant's head, have been destroyed. In this sculpture also the artist was influenced to a greater degree than in the more perfect head (Fig. 2) by the macaw-design, and instead of restricting the geometrical pattern, as in the latter, to the area of the pinna, encircled the eye with it (*c*). This occurs in a more striking form in the glyph (*b*), to which Prof. Tozzer refers. In other respects, however, this also represents an unmistakable elephant.

Prof. Tozzer argues that Bancroft's drawings do not represent elephants, but the long-nosed god B. But the "long-nosed god" of the old codices is as unmistakable an elephant as the Copan sculpture is. As Prof. Stempell remarked, in reference to it (see my first letter), no zoologist can have any doubt that it was the artist's intention to represent an elephant —or, as I would prefer to put it, to copy the drawing of an elephant. In this case again the method of conventionalising the elephant, and especially his tusk, is a close parallel to the Cambodian prototype.

As to the so-called "elephant mound" and "elephant pipes," I may say that in my memoir I have not based any part of the argument upon them. If they are genuine, they are of trifling value as corroboration, in comparison with the consideration that the whole of the legends centred around the rain-gods of India and Mexico (NATURE, December 16) witness to the truth of the identification of the "long-nosed god B" as the elephant of Indra, who has been confused with Indra himself. If the pipes are forgeries —and I am not unaware of the literature relating to the point raised by Prof. Tozzer—the maker of them must have been one of the most remarkable archæologists America has yet produced.

I may add, in conclusion, that the evidence provided by these American pictures of the elephant is merely one link in the chain of connection between the early civilisations of the Old World and the New, which my collaborators and I are now putting together. It will be so strong that it can never be broken.

Out of the vast mass of proofs which we have now accumulated I selected the elephant-story for publication in NATURE, because the criticism that invariably is levelled at most of our other evidence cannot be used in this case. It is usually argued that even the most complex designs and the most fantastic customs and beliefs may be invented independently the one of the other in widely separated localities. But even the Maya artist, skilled as he was in conventionalising, could not invent the elephant, even by making a grotesque caricature of a macaw.

Since I posted the foregoing comments on Prof. Tozzer's letter, the Editor has kindly submitted Dr. Spinden's letter to me. With the previous instalment of my letter, so as to put the critics' case fairly before readers of NATURE, I sent the same three of Dr. Spinden's drawings which he has now submitted to illustrate his letter. My letter in NATURE of December 16, as well as my reply to Prof. Tozzer, cover most of the issues raised by Dr. Spinden.

These two distinguished interpreters of Central American art can decide between themselves what the Yucatan "heads with projecting snouts" were really intended to represent.

As for the real intentions of the Copan artists, I am quite content to leave it to the readers of NATURE to decide for themselves whether the sculpture reproduced on November 25, p. 340, and here repeated (Fig. 2), was or was not meant to depict an elephant with his Indian rider. If further corroboration is wanted, I might refer them to the manner of representing such a rider and his head-dress in early Indian and Cambodian sculptures; and as for the spiral ornament, which probably originated in the Indian representations of Makara, I might direct attention to the Cambodian and Chinese variations of the spiral, all of which reappear in Mexico and Central America. I would especially refer to Laufer's monograph on "Jade" (Chicago Field Museum of Natural History, 1912, pl. xliii.), where a perfect prototype of the Copan spiral is represented upon a jade ornament of the Han dynasty.

Dr. Spinden's refusal to admit that the Copan sculptures represent elephants becomes more intelligible when one reads the statement in his monograph on "Maya Art" that he "does not care to dignify by refutation the numerous empty theories of ethnic connections between Central America and the Old World" (p. 231). This is the attitude of mind not

of the scientific investigator, but of the medieval theologian appealing to the emotions in defence of some dogma which is indefensible by reason.

G. ELLIOT SMITH.

The University, Manchester.

The Board of Education and Laboratory Work: A Correction.

ON p. 548 of NATURE (January 13) I stated that the Board of Education had suggested the substitution of lecture-demonstrations for laboratory work in schools. I have been informed that the apparently trustworthy information on which I relied was incorrect. It is satisfactory to be able to state authoritatively that the Board has made no such suggestion, nor was the Board responsible for the recent adoption of this form of retrenchment in certain schools.

G. F. DANIELL.

A TERRESTRIAL CRATER OF THE LUNAR TYPE.[1]

ALTHOUGH the memoir before us was read before the U.S. National Academy of Sciences so far back as six years ago, it has only recently been received, and it must always be regarded as a chief source of our information concerning one of the most striking features presented anywhere on the earth's surface. The author, who was one of the firm which obtained possession of the locality, has accumulated by persistent and accurate observation such a wealth of valuable information that his memoir will always remain of the highest scientific value.

Among the interesting phenomena revealed by the exploration of the western territories of the United States, none yield in importance to the remarkable ringed depression which received the name of "Coon Butte." Situated 70 miles from the famous Grand Canyon of the Colorado, and only 2½ miles from the Canyon Diablo, with its innumerable scattered meteorites, the strata underlying all three localities are the same and are perfectly horizontal. These well-known strata consist of 40 or 50 ft. of purplish-red sandstone, underlain successively by 250 to 300 ft. of limestone (carboniferous), and 1000ft. of white sandstone. Although these beds underlying the "butte" have been explored by numerous borings, neither in the strata themselves nor in the dark red sandstone rocks below them has the smallest indication of volcanic materials been met with; neither has the faintest trace of solfataric or other volcanic action been detected. The nearest scene of volcanic activity is found on a small scale nine miles away, and on a grander scale 40 miles farther. On the other hand, fragments of the famous "Canyon Diablo meteorite" (which contains diamonds with platinum and iridium) have been found in countless numbers in and around the "butte," and up to a distance of five miles around it.

The "crater" of Coon Butte is a depression, circular in form and about 4000 ft. in diameter, with a rim that rises 570 ft. above a floor, which is quite level except where obscured by talus from the rim. In this rim the limestone and sandstone rocks are seen to have undergone the most violent disturbance; they dip away from the centre at various angles up to 90°. For distances up to two miles from the "butte" ejected fragments of the strata are found, those of the limestone being great angular blocks up to thousands of tons in weight, while the sandstone is usually finely divided and often in a completely pulverised condition. The minute study of the ejected sandstones shows evidence of their having been subjected to most intense mechanical forces. In many cases the individual sand-grains are pulverised into a fine "silica-meal"; where, as generally happens, the original bedding planes are visible, they are seen to have been bent and twisted in the most striking manner, and in some cases a lamination cutting across the bedding planes has been induced strikingly similar to the cleavage of slaty rocks. More rarely fusion of the silica has taken place, and portions of the original sand-grains are involved in chalcedony, a pumice-like material being formed which floats in water.

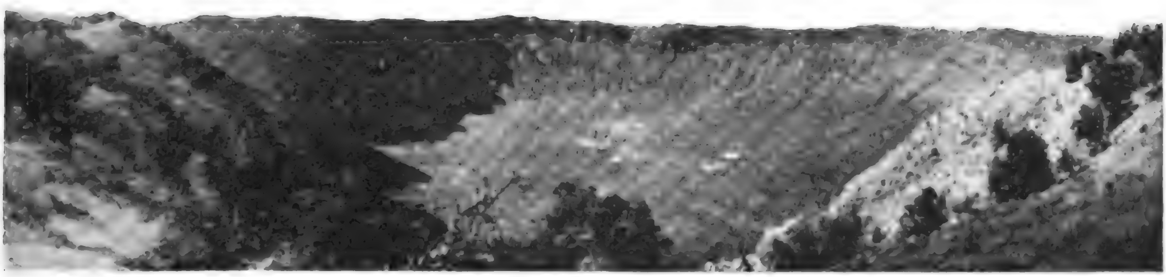

FIG. 1.—Interior view of crater, looking N.N.W.

Scattered among the other ejected fragments as well as in the "butte" itself are numerous examples of what the author calls "shale-balls," by others, perhaps more appropriately, designated

[1] "Meteor Crater (formerly called Coon Mountain or Coon Butte) in Northern Central Arizona." By D. M. Barringer. Paper read before the U.S. National Academy of Sciences.

"iron-shale." They are rounded or globular in form but never angular, and have the same "shaly" appearance as some of the sandstone fragments. On examination they prove to be oxidised masses of nickel-iron, and in some cases, in spite of their alteration, the Widmanstätten figures may be clearly recognised in them; they sometimes contain nuclei of unaltered nickel-iron. The larger of the well-known Canyon Diablo meteorites, which are of weights up to 300 or even 1000 lb., show no trace of alteration, but exhibit the pitted surfaces and other features of independent meteorites. Thus it would appear that at this locality there were two types of meteorites, one very easily acted upon by oxidation, and it is possible that some of the smaller "Canyon Diablo meteorites" may be only nuclei of the oxidisable variety.

All the American geologists who have studied the locality are in agreement as to the non-volcanic origin of this "crater"; Prof. G. K. Gilbert, however, has suggested a theory which has found wide acceptance. It is that the "crater" is due to the impact of a great meteorite or group of meteorites, which has produced the violent mechanical effects everywhere visible. The only analogous case that can be cited—and it is a rather remote one—is that of the meteorite of Knyahinya in Hungary, which weighed 660 lb., and, according to Haidinger, buried itself when it fell in 1866 to the depth of 17 ft., forming a circular pit 4 ft. in diameter and 4½ ft. deep. Coon Butte may not unnaturally be accepted as supplying a very suggestive explanation of the origin of the far larger lunar craters which present so many features in common with it.

It must be confessed, however, that many unsolved difficulties remain to prevent our unhesitating acceptance of the meteoric theory. Chief among these is the question of what has become of the vast mass of matter capable of producing the shattering impact. Only scattered fragments of nickel-iron have been detected at the depths reached by the borings, and the existence of a vast mass of meteoric iron at greater depths finds no confirmation from the magnetic observations carried on in and around the "butte." In an appendix to the memoir an account is given of a striking suggestion on the subject by Prof. H. N. Russell. He argues that a great meteorite or group of meteorites, moving with planetary velocities, would, on reaching our atmosphere, drive before it a "wad" of air capable of crushing out the great circular cavity, while this same air, in its upward escape, would effect the upheaval of the rocks of the rim and the ejection of materials to distances up to two miles from it. The problem of the existence of the great meteorite at considerable depths or its gradual disappearance by oxidation still remains.

It is evident that the striking characters of this singular "crater" are of no less interest to astronomers—so suggestive are the characters in which it agrees with the vast lunar craters—than to geologists, who up to the present have been chiefly attracted by the phenomenon.

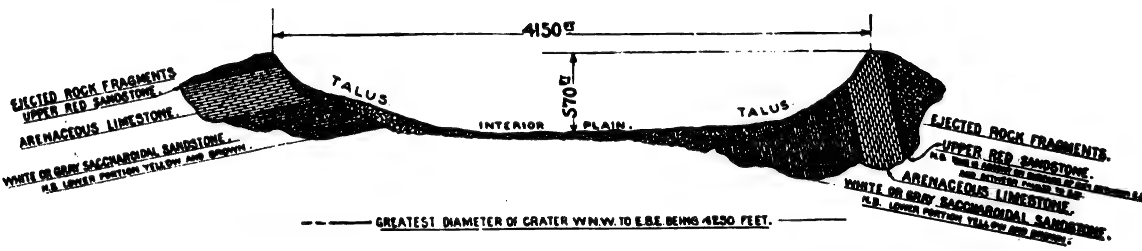

FIG. 2.—Cross-section of crater along a line approximately N.W. to S.E. Scale, about 1290 ft. = 1 in.

RECENT PUBLICATIONS OF THE CAPE OBSERVATORY.[1]

ALTHOUGH Sir David Gill retired from the direction of the Cape Observatory early in 1907, and died just seven years later, the volumes from that observatory which have recently been distributed are essentially his work. Even in the contributions of successor and collaborator Gill's inspiration and design are evident. It is not too much to say that the same spirit of energy and thoroughness will endure in the pages of future publications long after his name has disappeared from the title. No greater tribute can be paid to the memory of a great man. His personal achievement was considerable, but beyond that his influence on others will surely live.

These three volumes are typical of the three main currents to be observed in Gill's purely astronomical work. There is a zone of the Cape Astrographic Catalogue, a contribution to the great scheme of registering the positions of the stars by photography, with the inception and execution of which Gill was so largely identified. There is a volume of meridian work dealing both with the old transit circle and the new instru-

1 Cape Astrographic Zones. Vol. ii., Catalogue of Rectangular Co-ordinates and Diameters of Star-Images derived from Photographs taken at the Royal Observatory, Cape of Good Hope, commenced under the direction of Sir David Gill, completed and prepared for press under the supervision of S. S. Hough. Zone −42°. (Edinburgh: H.M.S.O.; London: Wyman and Sons, Ltd., 1914.) Price 20s.

Results of Meridian Observations of Stars made at the Royal Observatory, Cape of Good Hope, in the Years 1905 to 1908, under the direction of Sir David Gill and S. S. Hough. (Edinburgh: H.M.S.O.; London: Wyman and Sons, Ltd., 1914.) Price 30s.

Annals of the Cape Observatory. Vol. xii., Part i. Determination of the Mass of Jupiter and Elements of the Orbits of its Satellites from Observations made with the Cape Heliometer by Sir David Gill and W. H. Finlay. Reduced and discussed by Dr. W. De Sitter. Pp. 173. (Edinburgh: H.M.S.O.; London: Wyman and Sons, Ltd., 1915.) Price 6s.

ment which he designed with such careful attention to detail for the fundamental astronomy of position in the southern hemisphere. And finally there is a volume, or part of a volume, containing a fine series of measures with the heliometer, the instrument with which Gill's reputation as a practical observer is associated. The reductions in this case have been made by the present professor of astronomy at Leyden, and illustrate Gill's remarkable power of attracting young and talented astronomers to a distant observatory and enlisting collaboration from outside in the schemes which he had at heart.

The present instalment of the Astrographic Catalogue bears the date 1914. Since the first volume is dated 1913, and each contains nearly a tenth of the whole share allotted to the Cape Observatory, it may be surmised that the publication of the whole will be completed towards the year 1925. With some allowance for preliminary work, this means that about thirty years will have been spent in carrying out the project. Two observatories, Greenwich and Oxford, have already finished and published their sections. If this appears to imply that the Cape Observatory has been dilatory, it is fair to notice that the portion undertaken at the Cape is about 30 per cent. in excess of the average; that it was necessary to observe the reference stars simultaneously with the meridian circle; and that an extremely high standard of accuracy has been aimed at and probably attained. It is also quite possible that in spite of the apparent delay the Cape Observatory will be the third to finish. If this be confirmed by the event, the first three observatories to accomplish their task will all be British. This may prove to be the only satisfactory feature in an undertaking which bids fair to be a dismal failure in the field of international co-operation.

One feature presents itself at a casual glance through the catalogue. On the whole, the number of stars per plate is very high. But the run of the numbers is far from regular, and can scarcely correspond with real variations of the star density in the sky. The minimum magnitude recorded on a plate is not constant. This is confirmed by the result of comparing each plate with the overlapping plates, which often shows that the majority of the stars on one plate are unrecorded in the contiguous zones. It is not, of course, a defect peculiar to the Cape plates, though perhaps more conspicuous here because no indication is given of the magnitude scale, and because those stars are marked which are missing in the overlapping zones. It is a small point, doubtless, and the irregularity could scarcely have been avoided. But it illustrates the wisdom of the conference, which, starting out with the avowed object of securing a certain minimum magnitude, laid down a hard and fast rule defining the times of exposure without any regard to the quality of the night or the speed of the plates. As a matter of fact, the sensitiveness of the plates used has probably increased by at least one magnitude since the rule was formulated. Thereby, as though the work had not palpably overtaxed the resources of most of the observatories already, the labour and expense have been augmented in two ways, first by the increase in the number of star images, and then by the supposed need of revising earlier plates in order to conform with the higher numerical standard. When all is said and done, the limiting magnitude on any given astrographic plate is practically an undetermined quantity.

The volume dealing with the meridian observations made during the years 1905–8 contains much descriptive and tabular matter chiefly of interest to the specialist. The individual results obtained with the new reversible transit-circle and given here will be ultimately combined to form a fundamental catalogue. Most of the work done with the older instrument was carried out at the request of the late Prof. Boss, and has already appeared in catalogue form. A further list of 381 miscellaneous stars is now published in the same form. The individual observations of both lists will be found in this volume.

The heliometer observations of Jupiter's satellites, to the discussion of which the first part of vol. xii. of the Cape Annals is devoted, were made chiefly by Gill and on a few nights by Finlay in the autumn of 1891. They connect satellite with satellite, and do not involve the limb of the planet, the observation of which entails a lower order of accuracy. The main object in view was a determination of the mass of Jupiter, and this requires a most accurate knowledge of the scale value, to which the most careful attention was given. Corrections to all the elements of the satellites, except the mean motions, are involved, and no fewer than twenty-nine quantities enter into the final equations of condition. Duplicate solutions were made, one under the supervision of Mr. Hough, the other with different treatment by Prof. de Sitter. As regards the mass of Jupiter the final result is

$$1/1047{\cdot}50 \pm {\cdot}06.$$

Compared with the best results previously obtained, this value of the denominator seems a little high. H. C. P.

THE CLOSING OF MUSEUMS.

ACCORDING to the Secretary to the Treasury, "His Majesty's Government are of opinion that the following museums and galleries should be closed to the public: British Museum, Natural History Museum, Science Museum, Geological Museum, Bethnal Green Museum, Tate Gallery, National Portrait Gallery, Wallace Collection, London Museum." The precise sense of the word "should" will appear from events. At any rate, the decision has been made definite in the case of all departments of the British Museum except the reading-room, but the National Gallery and the Victoria and Albert Museum are not to be closed.

This decision will come as a severe blow to those who have been urging the need of a greater regard for science and education, but, in view of

the remarkable outburst of public opinion, it may still be possible to get its incidence modified. Let us consider what it means.

Fortunately, so far as we understand, it does not mean anything more than the closing of the galleries to the public. The ground alleged for this is not greater safety (a matter already attended to); it is in the main a question of economy and the turning of some of the staff on to more urgent work. But, as was well pointed out in a letter to Saturday's *Times* signed by "A Biological F.R.S.," the curatorial work must of necessity go on, some office staff must be kept up, and accredited students, many of whom are engaged on actual war-work, will presumably be admitted. The saving effected, whether considered absolutely or in relation to the total expenditure of ordinary times, is therefore small; the Government estimate is £50,000. In the case of the Natural History Museum, the largest of those with which our readers are chiefly concerned, it would seem possible to dispense with about sixteen commissionaires, two lavatory attendants, three or four cleaners, and perhaps as many police. There are, we believe, a very few employees still available for military service, and awaiting their call. For the rest, the staff cannot, consistently with the safety of the collections, be much further depleted. The museum estimates have already been enormously reduced, and any additional saving would be quite trivial in proportion. Not that the actual money will be saved, for the Government could not cast its employees adrift, but the labour can be directed to other purposes. This does not mean that two dozen stalwart men are set free to fight their country's battles, or even, for the most part, to make munitions. Perhaps some of these candidates for pensions are capable of light horticultural or clerical work, in any case of work for which they have not been trained.

Now is this really worth while? Here is a great building, which with its vast exhibited collections alone has been appraised at a million pounds, about to be closed to the public for the sake of so trivial a saving. Here is the centre of our Empire, thronged with its citizens from near and far, and they are to be precluded from seeing the gathered scientific (and many of the artistic) treasures of their nation. Here are our soldiers seeking refreshment for their minds deadened by the din of battle, and they are to be turned out to the public-house, the revue girl, and Charlie Chaplin. On grounds of pure economy we venture to predict that as much money will be wasted to the nation by this step as will ever be gained by it. Then there are the children, whose school-hours in many cases are shortened, whose teachers have obeyed other calls—they will no longer be able to have recourse to the museum which they are gradually learning to love; their pleasures must again be the pleasures of mean streets. As for the public with some leaning to nature or to art, those who spend a hard-earned half-holiday in gaining some useful knowledge, the public whom we have been trying to lead to a better appreciation of science—what will they think when they see that the first Government establishments to be closed are those devoted to the highest learning and the noblest forms of art? And we, what are we to think of a responsible Minister who can describe the museums as merely "places of pleasant resort"?

The truth is, the Government has been badgered to "give the country a lead" in this matter of economy; and at last it has led—along the line of least resistance. It is not because these are the departments in which anyone has ever hinted at waste; those who never have enough to spend are not likely to waste it. It is merely that the easy but conspicuous action of closing the museums may convince people that the Government "means business." Sensible folk here will soon see that as a business proposition there is nothing in it, and across the Channel, where they are trying to reopen such museums as had perforce to be closed, it will certainly not count as *un beau geste*.

NOTES.

ONE of the effects of the war has been to bring home more forcibly to the general public the part played by science in the growth of Germany's greatness as a nation. Several articles have already appeared in the reviews emphasising this, and the January number of the *English Review* contains a short sketch by Mr. H. L. Heathcote of the development of Germany's chemical industry. This will help to make better known the principles of action underlying Germany's success, in the past, in capturing so large a share of the world's trade. The growth of the industries of porcelain, glass, sugar, cyanide, and of acids and alkalis, is briefly described, and a short account is given of the inception of new industries, such as those of the incandescent mantle, the metal filament lamp, and the fixation of atmospheric nitrogen. In a sketch of the development of the dyestuff industry, it is pointed out that no amount of baseness in her conduct of war will ever quite eclipse, from the chemists of all nationalities, the greatness of Germany's achievements in organic chemistry, the most difficult of all chemical work. "State-aided chemical industry runs like a vein of gold through the statecraft of Germany, and if ever we learn what Kultur means we shall find that German chemical industry is its vital part." That the industry can be used in an almost unique way to assail the wealth of other nations is proved beyond question by past facts. It remains to be seen how far we, in the future, will profit as a nation from the most important lesson the war has to teach—that national greatness and even national security depend primarily on the degree to which science is encouraged and fostered by the State.

THE threatened prohibition by Sweden of the exportation of wood pulps awakens political interest in an important branch of our cellulose industries. The papermaking industry of Great Britain is chiefly dependent upon imported raw materials, of which about 80 per cent. are the wood pulps. In evidence of the growth of the industry, as of its collateral dependence upon exotic supplies, the importation of these wood pulp shows a tenfold increase for the period of 1887 to

1915—*i.e.* from 500,000*l.* to 5,000,000*l.* The values of total imports for 1915 are above six millions sterling, which includes esparto grass (700,000*l.*), rags and rag pulps, and miscellaneous raw materials. As to the distribution of the sources of supply of the wood pulps, a large part of the total—60 to 70 per cent.—is derived from Scandinavia, Norway sending a larger proportion of "mechanical" pulp, which is the basis of our newspapers, and Sweden the larger proportion of chemical pulp, used in higher class printings and also writings. The chemical pulps of the American continent, *i.e.* including Canada, are little exported, but a fairly large amount of "mechanical" pulp, that is, ground wood pulp, is obtained from Canada, and some from Newfoundland. Our dependence upon Scandinavia is obviously reciprocal; their wood-pulp industry, which is now a very important means of exploitation of their pine forests, is certainly of primary importance to them. The general conclusion of specialists is that Sweden cannot afford to enforce any such prohibition. It is probably a card played in the game of *haute politique,* and the solution of the matter is to be expected in some form of licence to export, similar to our licences in the case of sulphur and other products ranking directly or indirectly as "munitions."

On Thursday next, February 3, Prof. W. H. Bragg will deliver before the Chemical Society his lecture entitled "The Recent Work on X-Rays and Crystals and its Bearing on Chemistry."

At the annual general meeting of the Royal Meteorological Society held on January 19 the Symons Memorial gold medal, which is awarded biennially for distinguished work in connection with meteorological science, was presented for transmission to Dr. C. A. Angot, Bureau Central Météorologique de France.

At a meeting of the council of the Royal Society of Arts on Monday, January 24, the society's Albert medal was presented to Sir J. J. Thomson, "for his researches in chemistry and physics and their application to the advancement of arts, manufactures, and commerce." The medal was founded in 1863 as a memorial of H.R.H. the Prince Consort, and is awarded annually "for distinguished merit in promoting arts, manufactures, and commerce."

In order to secure the integrity of the estate of the Zoological Station at Naples, and to provide that its scientific function shall not be interrupted, the Royal Italian Government has appointed a committee, of which Prof. F. S. Monticelli is president, for the temporary and extraordinary administration of the Zoological Station. The committee will endeavour to provide the station with financial means for the development of its activities, particularly the fulfilment of its obligations towards the table-occupants. All communcations—financial and scientific—which may concern the station should be sent to Prof. Monticelli.

In view of the uncertainty as to the sufficiency of the supplies of sulphate of ammonia to meet the home demands during the next few months, it has been decided, on the recommendation of the Fertilisers' Committee, with the approval of the President of the Board of Agriculture and Fisheries and the President of the Board of Trade, to suspend for the present the issue of licences for the export of sulphate of ammonia. Under normal conditions it is well known that the production of sulphate of ammonia considerably exceeds home requirements, but Lord Selborne confidently hopes that farmers will this year greatly increase their demands for fertilisers of all descriptions so as to stimulate so far as practicable the production from the land, and thus reduce the importation of foodstuffs.

We referred in a leading article on December 23 to the question of an adequate supply of nitrates for agricultural and other purposes, and we commended it to one of the scientific committees which have been established since the outbreak of war. What is mainly wanted is a careful consideration of all available facts, so that a precise statement may be made of the possibilities of the synthetic production of nitrates in this country as a commercial enterprise. The subject is one that intimately concerns the Board of Agriculture; and it seemed to us that it could be considered appropriately by the Departmental Committee appointed by the President of the Board to make arrangements with a view to the maintenance, so far as possible, of adequate supplies of fertilisers for the use of farmers in the United Kingdom. We are glad to see, therefore, that the omission of a chemist from this committee, to which we directed attention in our article, has now been rectified. It has just been announced that the President of the Board has appointed Sir James J. Dobbie, F.R.S., Government Chemist, and Mr. J. R. Campbell, of the Department of Agriculture and Technical Instruction for Ireland, additional members of the committee. Mr. H. Chambers has been appointed secretary to the committee *vice* Mr. H. D. Vigor, resigned.

We learn from the *Chemist and Druggist* of the death, at seventy-five years of age, of Dr. R. C. Engel, professor of chemistry at the Ecole Centrale des Arts et Manufactures, Paris, and a corresponding member of the Academy of Medicine.

The death is announced, at the age of sixty-nine years, of Mr. H. M. O'Kelly, formerly superintendent of Government telegraphs in India. He joined the Indian Telegraph Department in 1866, was appointed superintendent in 1886, and retired in 1898.

We regret to announce that in the list of deaths due to the loss of the *Persia* is included the name of Mr. Robert Vane Russell, of the Indian Civil Service. Mr. Russell joined the service in 1893, and at the time of his death had reached the rank of Deputy Commissioner in the Central Provinces. His ability, powers of work, and knowledge of the people marked him out for early distinction, and in 1901 he conducted the census of the province and wrote a valuable report. After the completion of the census he was engaged on the revision of the series of district gazetteers, of some of which he was sole author, and all were improved by his wide knowledge of the country. But his most important work was the ethnographical survey of the province, to which his later years were devoted. He carried on this work with unfailing energy, in spite of the fact that a painful disease compelled him to

be almost entirely a recluse. He published as the preliminary studies of this work a series of monographs on castes, which are full of interest, particularly those devoted to the little-known forest tribes. It is a melancholy satisfaction to know that before he started on his last fatal voyage he was able to complete this great work on the "Tribes and Castes of the Central Provinces of India," which is announced for early publication by Messrs. Macmillan and Co., Ltd. By his early death the Indian Civil Service loses an officer of exceptional ability, and anthropology an energetic field worker and a competent authority on the general questions of ethnology, comparative religion, and folklore.

DR. REGINALD KOETTLITZ and his wife have died from dysentery at Somerset, South Africa, where Dr. Koettlitz was in practice. Born in 1861, educated at Dover College and Guy's Hospital, Dr. Koettlitz settled in a country practice in England, where he remained eight years, until he joined the Jackson-Harmsworth Polar Expedition in 1894. He remained three years continuously in Franz Josef Land, for he refused to return home when he had the opportunity, and leave the expedition without a medical officer. Dr. Koettlitz's geological researches in Franz Josef Land were most important and carried out under very adverse conditions. In 1898 he joined Mr. Weld Blundell when the latter accompanied Captain Harrington to Addis Abbeba, on his appointment to the court of the Emperor of Abyssinia. This entailed a journey through Somaliland and south Abyssinia to the Berta country and the Blue Nile, and home by the Sudan and Egypt. Later Dr. Koettlitz travelled in Brazil, and in 1902 joined the late Captain Scott as senior medical officer of the *Discovery*. He served throughout that expedition, and did much useful work. The Koettlitz Glacier remains as a memorial to his enthusiasm for travel and scientific research, and will keep alive the memory of his kindly and unselfish nature.

BY the death of Lieut. William Inchley, of the 2nd Duke of Wellington's Regiment, under shell fire in France, on December 19, 1915, a scientific career of great activity and high promise was cut short at the age of thirty-two years. On leaving school, Lieut. Inchley attended the engineering course at University College, Nottingham, and graduated B.Sc. (Engineering) with honours in the University of London. He was a brilliant student. In his second year at college he gained first prize and silver medal of the City and Guilds of London Institute in mechanical engineering, and in the next year their bronze medal and prize in electrical engineering. He was apprenticed to Messrs. R. Hornsby and Sons, Ltd., Grantham, and engaged on the design, construction, and testing of internal-combustion engines and steam boilers, and for two years acted as technical assistant to this firm. As a graduate of the Institution of Mechanical Engineers he gained a prize for a paper on "Steam Engine and Boiler Trials." From January, 1907, he was lecturer in mechanical and electrical engineering at University College, Nottingham. His paper on "The Calorific Value of Solid and Liquid Fuels" gives the results of a research, using the latest form of Mahler-Cook bomb calorimeter. He also recalculated Mahler's figures, and deduced simple empirical formulæ for the heating value of fuels which agree more closely with the values obtained by the bomb calorimeter than those given either by Dulong or Mahler. Lieut. Inchley wrote several books on engineering; his "Theory of Heat Engines" gives in a concise form thermodynamic and mechanical principles with many numerical examples. His book on "Steam Boilers" avoids advanced mathematics, even when dealing with heat transmission. He was also joint-author of "Elementary Applied Mechanics." All who were associated with him in his life-work will long cherish the memory of his devotion to duty. His death is not only a severe loss to his wife and three young children, but also to University College, Nottingham, and his country.

WE learn with regret of the death, in his seventy-seventh year, of Prof. Paul Sorauer, of the University of Berlin. He early won recognition by his "Beiträge zur Keimungsgeschichte der Kartoffelknolle," published in 1868. Six years later appeared the "Handbuch der Pflanzenkrankheiten," written whilst Sorauer was director of the Experimental Station for Plant Physiology at the Imperial Cider Institute of Proskau. This work, which was the first comprehensive presentation of the rapidly growing science of plant pathology, immediately raised the author to a leading position. A new edition, twelve years later, is noteworthy for the author's acceptance of the then heretical doctrine of the importance of bacteria as causal agents of disease in plants. The last edition, completed in 1911, must remain for many years the most authoritative exposition of this subject, and we are glad to note that it is being rendered accessible to English readers. In the meantime appeared many other of his valuable works dealing with various aspects of plant pathology, and the eminently readable "Populäre Pflanzenphysiologie," which has since been translated into English by Weiss. In 1891, the *Zeitschrift fur Pflanzenkrankheiten* was founded under the auspices of the "Internationalen Phytopathologischen Kommission," and Sorauer became editor, a position he occupied until his death. During that time he contributed more than thirty articles embodying original research to this publication alone, which latter under his guidance remained the leading phytopathological journal. Whilst it is by his "Handbuch," the successive editions of which mark epochs in the history of the study of disease in plants, that Sorauer will live, his enthusiasm and untiring energy in all international phytopathological activities are worthy of the fullest recognition, and have had a predominating influence in what has been achieved to that end.

THE *Scotia*, which was the vessel that carried the Scottish National Antarctic Expedition to the south polar regions, under the command of Dr. W. S. Bruce, has been burnt in the Bristol Channel, and has been run ashore at Sully. It was hoped at the end of the expedition that the *Scotia* might be further endowed and handed over to the universities of Scotland as a well-fitted oceanographical ship, but this was not to be, and she fell to the hammer as a whaler. Later,

however, she was chartered by the Board of Trade as the most suitable vessel on which to carry out ice observation, meteorology, and oceanography in the North Atlantic Ocean after the wreck of the *Titanic*. The results obtained during this voyage in 1913 have been published by the Board of Trade in two volumes.

THE Midlands earthquake of January 14 proves to have been felt much more widely than was at first supposed. Though less strong than several other British earthquakes of the last quarter of a century, it was perceived by a large number of persons on the first and second floors of houses at a great distance from the centre. The disturbed area includes all England, with the exception of the counties of Northumberland and Durham, the northern half of Cumberland, and the southern counties bounded by a line drawn from Bridgwater in Somerset, by Salisbury, and Guildford, to the mouth of the Thames. It thus includes about 45,000 square miles. From a first rough analysis of the accounts received by him, Dr. Davison concludes that the centre of the innermost isoseismal line was not far from Stone, in Staffordshire. The western boundary of the disturbed area, however, is somewhat uncertain, and Dr. Davison (whose address is 16 Manor Road, Birmingham) would be very glad to receive notices of the earthquake from any part of Wales. He is also anxious to obtain many more observations from the central area, especially from the district within twenty or thirty miles of Stone, and would send forms to anyone able and willing to supply the information desired. We have also received a request from Mr. J. J. Shaw (Sunnyside, West Bromwich), secretary of the Seismological Committee of the British Association, for information with reference to the time of occurrence and the nature and intensity of the shock.

MR. L. MACLENNAN MANN has issued an interesting pamphlet on archaic sculpturings, in which he proposes a new explanation of the mysterious cup-markings. Plotting them on sheets, he believes that he has discovered that they assume well-defined geometrical forms. The north and south line often runs through one centre, and through another centre runs another north and south line diverging from the first by two to four degrees. Up to the present his survey seems to have been practically confined to the districts of Dumfries and Galloway. With this theory in the minds of inquirers, it is desirable that a wider examination of these sculpturings in other localities should be prosecuted.

THE number of birds new to the British list is steadily increasing, though it is probable that many now recognised for the first time have frequently occurred on our shores, but have escaped detection. The vigilance of our ornithologists is greater than it was, and their powers of discrimination are keener. Hence it is now possible to distinguish not only between our own sedentary species and the Continental races thereof, which more or less frequently visit us, but also between different Continental races of species which visit us, apparently, only on rare occasions. No fewer than six species new to the British list are described in the *British Birds* magazine for January. The value of such records would surely be materially increased if some attempt were made to discover the prevailing weather conditions just before and during each of these recorded visitations.

FOR some time past a correspondence has been carried on in the daily Press as to the fate of the house-fly and the bluebottle, or blow-fly, in the autumn. Do they die, leaving pupæ to continue the race, or do they hibernate, and, reappearing in the spring, produce new generations of larvæ? The latter view is advocated by the non-experts, some of whom claim to have found hibernating individuals of both the species in question. It would seem, however, that but little trust can be placed on their evidence, for though numerous consignments of supposed hibernating individuals of these species have been sent to the British Museum of Natural History, not one contained either house-flies or bluebottles. In one case more than 200 supposed house-flies were sent, but on examination about 80 per cent proved to be cluster-flies (*Pollenia rudis*); there was not a single house-fly among them. The fact is not generally known that there are two or three distinct species of fly which closely resemble the house-fly, and these actually do hibernate, choosing our houses for that purpose, hence the confusion that has arisen.

AT the monthly general meeting of the Zoological Society, held on January 19, Prof. Lucien Cuénot, Dr. Clementi Onelli, and Count Mario Peracea were elected corresponding members, and Prof. Eli Metchnikoff a foreign member of the society. The additions to the menagerie numbered 107, including three species new to the collection: a Salt Desert cat (*Felis salinarum*), two sand hamsters (*Cricetulus griseus*), and an Allemand's Grison (*Grison allemandi*). Though the number of visitors for the year 1915 showed an increase of 3520 over the number admitted during 1914, the receipts for admission at the gates showed a decrease of 1283*l*., as compared with the previous year. The total number of visitors during 1915 amounted to 1,058,728. In normal times this decrease in the receipts might well cause anxiety; as it is, these figures rather afford an occasion for congratulation. Far otherwise is it with similar institutions among those now at enmity with us. In Budapest we learn that the lions are now fed on half rations, which are partly furnished by the slaughter of the less valuable examples of goats and sheep. The seals have had to be killed for lack of fish, and a similar fate has overtaken the polar bears, for the shooting of which the director opened a competition, by way of raising a little ready cash! The herbivorous animals are in no better case, for the shortage of hay is so great that the deficit has to be made good by substituting wild chestnuts.

THE Geological Survey of New Zealand is making progress with well-illustrated descriptions of the fossils of that colony, which have long been desired for comparison with the corresponding fossils of other regions in the southern hemisphere. In Palæontological Bulletin No. 3, just received, Mr. H. Suter continues his revision of Hutton's type specimens of Tertiary Mollusca.

THE last number of the *Revista* of the National University of Cordoba (Argentine Republic) deals chiefly with subjects of medical and historical interest. In one article, however, Prof. Angel Gallardo refers to the richness of the collections in different institutions in the city, and urges the importance of the foundation of a Provincial Museum, with facilities for original research.

THE *National Geographic Magazine* for November, 1915 (vol. xxviii., No. 5) maintains its reputation for well-illustrated articles. The greater part of the issue is devoted to a general descriptive article on France, with more than one hundred illustrations, by Mr. A. S. Riggs. Many of the pictures are excellent, and most are quite new. A short article on the Citizen Army of Switzerland, with some pictures of the army amid the alpine snows, completes the number, except for sixteen colour photographs of miscellaneous geographical subjects illustrating, in the main, types of European peasants.

MR. P. W. STUART-MENTEATH is well known through his geological studies in the Pyrenees, which have now extended over forty years, and it is highly probable that in many points of detail he can correct the maps and sections of those who have made sweeping surveys of the chain. The twelfth part of his descriptions of the "Gisements métallifères des Pyrénées-Occidentales" has appeared in the *Boletin de la Sociedad Aragonesa de Ciencias Naturales*, and is chiefly concerned with the retention in the Cretaceous system of beds placed by Prof. Termier as Silurian, and the extension of the Cretaceous zones in areas recently mapped as Palæozoic. A close acquaintance with the strata would be required for the appreciation of the merits of the author's controversy with M. Léon Bertrand, or the older one as to the age of the overfolds in the Pyrenees, and of the alleged Carboniferous granite of Gavarnie ("La nueva Geologia en los Pirineas de Aragón," *Mem. del primer Congreso de Naturalistas Españoles*, 1909).

A SUMMARY of temperature, rainfall, and bright sunshine for the year 1915, obtained from the records of the fifty-two weeks ending January 1 of the present year, has been given by the Meteorological Office. The mean temperature for the year is in fair agreement with the average over the whole of the United Kingdom, but is generally slightly deficient, the greatest deficiency amounting to 1° in the east of Scotland and to nearly that amount in the west of Scotland. The rainfall for the year was in excess of the average in all the eastern districts, the amounts ranging from 130 per cent. of the average in the south-east of England, where commonly of late the rains have been abnormally heavy, and 123 per cent. in the east of England to 107 per cent. in the north-east of England. In the western districts the rainfall was more variable, ranging from 111 per cent. of the average in the south-west of England and 105 per cent. in the south of Ireland, to 80 per cent. in the west of Scotland, which has the greatest deficiency. In the north of Scotland the rainfall was 82 per cent. of the average, and in the Channel Islands it was 114 per cent. of the normal. The number of rainy days was less than the average except in the east of England and in the south of Ireland; in the south-east of England, where the greatest excess of rain was experienced, the rainy days were fourteen fewer than the normal. The duration of sunshine differed very little from the average, except in the north-west of England, where the total for the year had the average excess of half an hour per day.

THE seventh volume of the Journal of the Municipal School of Technology, Manchester, records the research work published by the staff and students during 1913. It extends to 200 pages, and includes important papers by Mr. W. C. Popplewell on the properties of reinforced concrete, by Prof. Knecht and by Mr. Hubner on dyeing and its history, by Prof. Miles Walker on the training of the engineer, and eleven other papers mainly on technical chemistry. In addition to the scientific interest provided in these records there is a preparatory note of a page and a half which tells something about the work of the school, and will serve as a guide to the authorities of many schools who have not yet realised what is the great need of the country in the matter of technical education. The first place in the note is given to the three or four hundred university students who have passed the matriculation examination and are taking a three years' course in order to graduate. It appears that the school cannot turn out graduates fast enough to meet the industrial demand for such men. As this is also the experience of the Central Technical College in London, it is a serious question whether those technical schools which complain that the industries show no appreciation of their students are turning out properly qualified men, or only men who, to make up for the deficiencies of their early training, obtain a smattering of scientific knowledge by attending evening classes when tired out with their day's work?

COSTING, in round figures, $1\frac{3}{4}$ million pounds, and comprising 880,000 cubic yards of cyclopean concrete masonry, the Kensico Dam, one of the principal features of the Catskill water supply system of New York City, has just been completed. The event is the more notable for the fact that the work has been carried out in the relatively short space of four and a half years, or three years less than the contract time—a remarkable achievement in days when experience is usually of the reverse kind. The Kensico Reservoir, destined to provide storage capacity for two and a half months' supply, is formed in the valley of the Bronx River, on the east side of the Hudson, thirty miles north of New York City. The dam takes the place of an earlier structure of much less height, enclosing a correspondingly smaller area; the increase in effective height is actually 110 ft., and in area, 3200 acres. According to the *Engineer* of January 7, the preparation of the foundation involved the removal of $2\frac{1}{2}$ million cubic yards of earth and rock, and, in one place, the rock had to be drilled and blasted to a depth of 65 ft. The work of laying the masonry reached the record figure of 84,450 cubic yards in a single month. Electric power plant was extensively employed, and a special installation was laid down for the purpose. For the measurement of the water

drawn from the reservoir, there is provided a very large Venturi meter, 410 ft. long, formed in reinforced concrete, with bronze throat castings and piezometer ring. The protection of the surrounding area has been effected by planting the banks with *Arbor vitæ*, with pine and spruce seedlings in the rear, which will also serve the purpose of minimising the evil of drifting deciduous leaves.

WE are asked by Mr. J. Reid Moir to state that the arrangement of the collection of flint implements which, as announced last week (p. 572), has recently come into the possession of the Ipswich Museum, is entrusted to the curator, Mr. Frank Woolnough, and himself, and not to Mr. J. Reid Moir alone.

OUR ASTRONOMICAL COLUMN.

COMET 1915*e* (TAYLOR).—The following is a continuation of the ephemeris based on the orbit given last week:—

		h.	m.	s.	°	′			h.	m.	s.	°	′
Jan.	28	5	13	48	+19	8·1	Feb.	3	5	19	44	+21	29·5
	30		15	35	19	56·3		5		22	6	22	14·4
Feb.	1		17	34	20	43·4		7		24	40	22	58·2

It will be seen that the comet is moving on the line 15 Orionis–114 Tauri, and should be close to the latter on February 5. According to an observation made at the Hill Observatory on January 22, the ephemeris required corrections of −22 sec. in R.A., and −15′ in declination. The former has more than doubled since January 13, but the latter has remained practically unchanged.

THE NOTATION OF STAR COLOURS.—The combination of photographic and photovisual photometry, as well as more direct methods, provide a measure of the colour index which can be expressed as a sum of terms due to the spectrum of the star, its absolute magnitude, and its distance. To break up into defined groups the numerical colour indices Prof. F. H. Seares proposes colour classes corresponding to the means for the typical spectra of classes B, A, F, etc., with the designations *b, a, f*, etc. By making certain numerical definitions, the difference between the colour symbols and the spectrum symbols expresses the abnormality of the individual as regards luminosity and distance. Such colour symbols may be termed "hypothetical spectra."

SATURN'S RINGS.—Speculation is only beginning to become again active in regard to the ring system of Saturn since Keeler elucidated the mystery of its constitution. Thus there is the question of its origin, perhaps indeterminate, as it admits of a number of almost equally plausible suggestions. A more limited problem concerns the subdivisions. What is the meaning of the manifold "rings"? In bringing forward this problem, Dr. Lowell (Lowell Observatory Bull., No. 68) suggests, and advances proof in the form of filar micrometer measures of their dimensions, that many of the newly-detected divisions on ring B are due to the perturbative action of Mimas (the nearest of Saturn's satellites, half the diameter and half as far away as the moon is from the earth). The proof offered is the fact that most of the new divisions occur where a particle of the ring would have a period of revolution commensurate with that of Mimas in some simple ratio. New divisions are situated 1/4, 3/7, 4/7, 1/3 − and 1/3 + way out from the inner edge of ring B respectively, and the corresponding periods would be 3/8, 2/5, 3/7, 4/9, and 5/11 that of Mimas. Dr. Lowell some time ago directed attention to simple commensurabilities among planetary periods (NATURE, July 24, 1913). The question naturally arises whether Mimas is making new satellites for Saturn out of the meteoritic material of ring B.

STEREOSCOPIC MEASUREMENT OF PROPER MOTIONS.—M. Comas Solà recently gave an example of the use of an ordinary stereoscope for the detection of proper motions (NATURE, August 26, 1915). Apart from Prof. Barnard's criticism of the results, this simple instrument obviously cannot yield quantitative information. This deficiency, however, appears to be removed by the addition of an arrangement M. Comas Solà has named a stereogoniometer (*Comptes rendus*, clxii., p. 39). This is a device by which the two properly oriented plates under comparison may be simultaneously rotated through a measured angle. As the plates rotate so the apparent "relief" of the proper motion star alters, the position of maximum relief giving the direction of the star's movement. It may be pardonable to add that the obvious experiment is very interesting.

PROF. GUIDO BACCELLI.

WE are indebted to the *British Medical Journal* for the following particulars of the career and work of Prof. G. Baccelli, whose death was announced in NATURE of January 13. Prof. Baccelli was born in Rome on November 25, 1832, and took his doctor's degree in the university of his native city in 1852. Four years later he was appointed to the chair of forensic medicine in the University of Rome, but resigned his position after two years, and devoted himself to the study of morbid anatomy. When a chair of that subject was founded in the University Baccelli was appointed the first professor. In that capacity he had a great influence in turning the minds of his pupils in the direction of modern scientific methods. In 1863 he was appointed lecturer on clinical medicine, and in 1870, when Rome became the capital of Italy, he was appointed professor of clinical medicine, a post which he continued to hold until the end of his life. In 1875 he entered the Italian Parliament as one of the deputies for Rome, and soon took a leading place as a politician. In 1881 he became Minister of Public Instruction, and held that portfolio four times in all, doing great service to his country by the promotion of far-reaching reforms, both of primary and university education. To him Rome chiefly owes the Policlinico, a magnificent pile of buildings, fully equipped for the study of disease. He was also once Minister of Agriculture, Industry, and Commerce. He was prominent as a sanitary reformer, and was at one time President of the Board of Health. He took an active part in the sanitary improvement of the Campagna; for his efforts in that direction he received the thanks of the Italian Parliament. He was a Senator of Italy. Prof. Baccelli was president of the eleventh International Congress of Medicine held in Rome in 1894, and at that congress he made a powerful appeal for the introduction of Latin as a universal spoken language which could be understood all over the world. A little modification in the teaching of Latin in schools as a spoken and not merely as a dead language would give all the advantage of the attempts which have been made to construct a universal language, while it would not disorganise the present curriculum and would render available for general use all the stores of wisdom and knowledge contained in Latin books and at present unavailable for common use. Besides a monograph on Roman malaria, published in 1878, in which his views on the sanitary improvement of the Campagna were embodied, Prof. Baccelli was the author of many

contributions to medical literature, among them being a treatise in four volumes on the pathology of the heart and aorta; clinical lectures on malaria; subcontinuous fevers, containing his earliest researches on malaria; and State medicine and clinical medicine in ancient and modern Rome.

RESEARCH IN TERRESTRIAL MAGNETISM.[1]

THE handsomely printed and illustrated volume before us records the activity of the Department of Terrestrial Magnetism by *land* from 1911 to 1913. In pp. 5–20 we have an account, illustrated in plates 2, 3, and 4, of instruments used in the world survey on which the department has been engaged since 1905. Pp. 21–182 deal with the land observations made during 1911 to 1913. The names of thirty-four observers are recorded on p. 23. Of the 983 stations occupied, 207 were in Africa, including 106 in Algeria and the Algerian Sahara, 52 in French West Africa, and 13 in Morocco. In Asia there were 83 stations, 59 being in China or Indo-China. There were 284 stations in Australasia, and 247 in South America, the latter distributed in eleven countries, 63 stations being in Peru and 52 in Brazil; 46 stations were occupied in islands in the Pacific, Atlantic, and Indian Oceans, and 30 in the Antarctic, by members of Sir Douglas Mawson's Expedition, trained and supplied with instruments by the department. The results are tabulated on pp. 26–64 of the volume. The following sixty-four pages are devoted to the observers' reports, illustrated by seventeen photographs in plates 5, 6, and 7.

One of the most interesting reports is Mr. D. W. Berky's account of his travels from Algiers to Timbuktu, which includes varied information as to camels and wild life in the Niger. On several occasions in the Sahara such heavy electrical charges from wind-driven sand appeared on the instruments that observation was impossible. On one occasion half-inch sparks were drawn when the instrument was touched. Another interesting narrative is that of Mr. H. M. W. Edmonds, who occupied thirty-eight stations, mostly in remote parts of Canada, travelling more than 2000 miles by canoe. One of the largest pieces of work was a magnetic survey of Australia carried out by Mr. E. Kidson and three assistants. During 1910 and the first half of 1911 Mr. W. H. Sligh travelled 22,000 miles, commencing observations at Constantinople and finishing up with Helwan. His eighty-four stations included Jerusalem, Jericho, Damascus, Smyrna, Bagdad, Bombay, Aden, and Suez. Particulars of the several stations occupied by all the observers occupy pp. 130 to 182.

Pp. 185–200 describe the new headquarters of the department in Washington, comprising a commodious main building, which cost, without equipment, 68,000 dollars, and a standardising observatory of wood. A high tower is in contemplation for atmospheric electricity. The buildings are shown in plates 1, 8, and 9. On pp. 201–209, and in plate 10, the director, Dr. Bauer, deals with a nine-months' trip which he made in 1911, when he travelled 47,000 miles, visited eighteen magnetic observatories, including Mauritius, Dehra Dun, Buitenzorg, Christchurch, N.Z., Tsingtau, and Tokio, and observed during a total solar eclipse in Samoa.

The final section, pp. 211–278, discusses the comparisons made since 1905 of the standard magnetic instruments at some thirty observatories, photographs of eighteen of which are shown in plates 11, 12, and 13. In the case of H (horizontal force) it is assumed that the correction to the value observed with a particular instrument is proportional to the local value of H. This is true when the sole cause is error in the calculated moment of inertia of the magnet. There are, however, other less universal causes of error which may follow different laws. Two ultimate standards are mainly referred to, entitled C.I.W. (Carnegie Institution, Washington) and I.M.S. (International Magnetic Standards). The C.I.W. standard is that to which all the department's land observations from 1905–13 have been reduced. It is embodied in a certain magnetometer and dip-inductor, with specific small corrections applied. The I.M.S. standards in D (declination) and H represent a mean from 42 magnetometers, 22 belonging to the department; while the I.M.S. standard for I (inclination) represents a mean from 25 dip circles, the majority by Dover, and 18 dip inductors. The differences between the C.I.W. and I.M.S. standards are given as 0·1′ in D, 0·5′ in I, and 0·00015 H in H. The authors think that if suitable precautions are observed the magnetic standards at an observatory should maintain for a period of five to ten years constancy to within 0·2′ in D and I, and 0·00015 H in H. The comparisons between the C.I.W. standards and those at Potsdam and Kew, "two observatories where . . . every care is bestowed upon instruments and constants," show, it is said, no changes not reasonably assignable to observational errors. The authors add:—"No undue significance is to be attached to the circumstance that the corrections for the Washington standards (on the I.M.S. scale) are apparently the smallest of the three observatories." The Washington standard magnetometer is, in fact, believed to give values for H exactly midway between those given by the Kew and Potsdam standards, which are supposed to differ by 16 parts in 100,000.

The work represents a large amount of accumulated experience and will doubtless be widely read by magneticians.

C. CHREE.

[1] Researches of the Department of Terrestrial Magnetism (Carnegie Institution of Washington). Vol. ii. Land Magnetic Observations, 1911–13, and Reports on Special Researches, by L. A. Bauer, Director, and J. A. Fleming, Chief Magnetician. Pp. 278+13 plates. (Washington, D.C.: Carnegie Institution, 1915.)

BIRD MIGRATION IN AMERICA.[1]

THE latest contribution by Mr. W. W. Cooke to the literature on bird migration deals with the general subject, especially in its American aspects, and is of an acceptable and interesting character. To condense into a brochure of forty-seven pages the main conclusions drawn from observations extending over more than twenty-five years, during which 500,000 records were communicated by some 2000 observers located in all parts of North America, is an achievement worthy of admiration.

Written in a lucid manner, it affords useful information on the many-sided subject on which it treats, among others on the causes of migration; weather relations; day and night migrants; distances travelled; routes; speed; how birds find their way; influence of temperature, etc. In treating of these the author has drawn his conclusions from the movements of a number of typical American migratory birds, and to exemplify them more effectually has introduced a series of maps and diagrams showing the summer and winter distribution of each species treated of, migration routes, isochronal migration lines, etc. These serve, among other purposes, to illustrate Mr. Cooke's conclusions with regard to the routes taken by the migrants when crossing the Gulf of Mexico, showing that by far the greatest number of migrants choose the shortest route

[1] "Bird Migration." By Wells W. Cooke, United States Department of Agriculture. Bulletin No. 185. (Washington, D.C., 1915.) Price 10 cents.

across the Gulf. Some birds, as, for instance, the American redstart (*Setophaga ruticilla*), cross on a front of more than 2000 miles from east to west. Others again cross on a narrow front, as in the case of the red-breasted grosbeak (*Zamelodia ludoviciana*), which, although the breeding range has a width of 2500 miles from east to west, converge, until they leave the United States along a line of Gulf coast only 800 miles wide.

One of the most interesting of the species treated of in this work is the bobolink (*Dolichonyx oryzivorus*). Our author tells us that "in the case of the bobolink the evolution of a new extension of the migration route is now occurring before our very eyes. By nature a lover of damp meadows, the bobolink was formerly cut off from the western States by the intervening arid region. But with the advent of irrigation and the bringing of large areas under cultivation, little colonies of nesting bobolinks are beginning to appear here and there almost to the Pacific," an excellent demonstration of the intimate relation between ecological conditions and geographical distribution. These individuals are stated to "return over the old route and show no disposition to shorten the flight by direct trip across New Mexico to the Gulf coast of Texas." The author, however, like many other writers on this subject, seems too prone to believe that most birds that pass are necessarily recorded. This, however, is absolutely impossible, even on a small and confined space; how much more so on a great continent such as America? The remarks on the red-eyed vireo (*Vireosylva olivacea*) as an example of a recent extension of breeding range and consequent elongation of migration route are of much interest. The extraordinary overseas flight of the American golden plover (*Charadrius dominicus*) in autumn is also referred to, as well as the curious elliptical form its migration takes at that season, the spring route being quite different from that of the autumn. Another most interesting and less known example of an elliptical migration route is that of the white-winged scoter (*Oidemia deglandi*), of which a full description and map are given. Mr. Cooke also directs attention to relative speed of various species on northward migration; as an example of slow and uniform migration he instances the black and white warbler (*Mniotilta varia*), to which he assigns an average speed of twenty-five miles a day during its northward passage from Florida to its breeding places in south-eastern Canada. On the other hand, as an example of rapid migration, the grey-cheeked thrush (*Hylocichla aliciae*) is instanced, this bird being allotted a speed of 130 miles a day for its journey of approximately 4000 miles; in the last part of the route, however, the speed is much greater than in the Mississippi valley. Another point touched on is the condition in which birds arrive at the end of a long migration flight, and the conclusion arrived at is that birds are not exhausted by their aerial journeys. This is, no doubt, largely the case in the western hemisphere, where the migratory movements are mainly performed overland from the equator to the Arctic regions; but in the Old World, especially in the British Isles, the migrants arriving after overseas flights often suffer much from exhaustion, even when the journey has been accomplished under the most favourable weather conditions. In this and in other respects, Mr. Cooke's work affords interesting comparisons between migration phenomena as observed in North America and in the British Isles.

Our author believes that food supply is the primary cause of migration; he says the "conclusion is inevitable that the advantages of the United States and Canada as a summer home, and the superb conditions of climate and food for the successful rearing of a nestful of voracious young, far overbalance the hazards and disasters of the journey thither. For these periodical trips did not just happen in their present form; each migration route, however long and complex, is but the present stage in development of a flight that at first was short, easily accomplished, and free from danger. Each lengthening of the course was adopted permanently, only after experience through many generations had proved its advantages," a sound statement, and one that is often in danger of being forgotten. Many other important points are dealt with in Mr. Cooke's pamphlet, but enough has been said to indicate its comprehensive and valuable nature: it should be read by all who are interested in the subject.

W. E. C.

SOLVENTS AND SOLUTIONS.[1]

THE appearance of each volume published by the Carnegie Institution of Washington induces in us a feeling of envy towards our American *confrères* on account of the facilities thereby afforded to them for the publication in collected form of the results of investigations which otherwise would appear only in small instalments and scattered throughout the various volumes of scientific journals. Through the appearance in such a collected form of the results obtained in a series of investigations bearing on one main question, it becomes possible for other scientific workers to realise more clearly the actual extent of the advance made. For such publications as the present, therefore, all workers on solutions will be grateful.

The present monograph deals with a wide variety of subjects, nearly all of them, however, suggested by the solvate theory of solution so familiarly associated with the name of the chief author of this publication.

In the ten chapters into which the discussion is subdivided, we find the following subjects dealt with:—Viscosities of solutions of cæsium salts in mixed solvents; conductivities of formamide solutions; radiometric measurements of the ionisation constants of indicators; influence of salts on the velocity of saponification and on the hydration of acetic anhydride; conductivity of organic acids in ethyl alcohol; conductivities and dissociation of some rather unusual salts in aqueous solution; the dissociating powers of free and of combined water; the absorption of potassium from aqueous solutions of potassium chloride.

Of the different contributions, the most interesting are, perhaps, the two dealing with the radio-metric measurements of the ionisation constants of indicators. By means of a grating and a radio-micrometer, of which a description is given, the light transmitted by solutions of methyl-orange and of rosolic acid have been determined. From these determinations the ionisation constants of the indicators could be calculated. In view of the excellent apparatus which the authors possess, further valuable work on a difficult problem may be hopefully expected.

A. F.

THE FRUITS, PROSPECTS, AND LESSONS OF RECENT BIOLOGICAL RESEARCH.[2]

THE general welfare of mankind has been wonderfully promoted during the past 150 years by the rapid progress of chemical, physical, and biological science. In the early third of that period, physics and chemistry and their applications seem to have played the most active parts in promoting human welfare, although pure botany and zoology enlisted

[1] "Conductivities and Viscosities in Pure and in Mixed Solvents. Radiometric Measurements of the Ionisation Constants of Indicators." By H. C. Jones and Collaborators. Publication No. 230. (Washington D.C.: Carnegie Institution, 1915.)

[2] Presidential address delivered to the American Association for the Advancement of Science at Columbus, Ohio, on December 27, 1915, by Dr. Charles W. Eliot.

many devoted workers, and made great advances; but during the past one hundred years it is biological science that has contributed most to the well-being of humanity. The new methods of transportation and of manufacturing by the aid of machinery with steam as motive power were products of applied physics. So were the great works of civil and mechanical engineering. The improved agriculture of the last half of the nineteenth century was partly due to new tools and machinery, and partly to new applications of chemical knowledge. Latterly biological science has helped the farmer very much to raise better crops and animals, and to protect his products from vegetable and animal pests.

While the industrial and social changes which applied physics and chemistry made possible unquestionably improved the general condition of mankind as regards bodily comfort, security against natural catastrophes, longevity, and an increased sense of mutual support and community interest through the vast improvement in the means of communication, these changes have all been *indirect* influences on human well-being and happiness, and with the good they brought much evil was mixed. Thus, the factory system, the congestion of population, and the noise and turmoil of city life are grave evils accompanying the advantages which applied physics and chemistry have created and diffused. The fruits of the biological sciences—botany, zoology, physiology, and biochemistry, applied to curative medicine and surgery and to preventive medicine and sanitation—have been *direct* contributions to human welfare; because they have provided defences against disease, premature death, and individual and family distress and suffering. The beneficent applications of biological science, unlike most of the large results of applied chemistry and physics, take effect in the field of human affections and family experiences, make life less anxious and more enjoyable for multitudes of human beings, mitigate or abolish ancient agonies and dreads of the race, and promise for it a happier future.

The career of Pasteur illustrates admirably the passing of the centre of beneficent scientific research from chemistry and physics to biological science. Pasteur's first researches were crystallographic; whence he passed to the study of molecular dissymmetry, the material of his researches being, however, organic. He was first professor of physics and then professor of chemistry. His interest in certain tartrates led him naturally, though partly by accident, to a study of fermentation. His zealous discharge of his duties as dean of a faculty of sciences at Lille, a manufacturing centre, led to his study of beetroot juice, fermented in order to produce alcohol. Thereafter Pasteur's researches were biological, although he had had no training as either naturalist or physician. He began at the foundation by disproving the doctrine of spontaneous generation. One of his earliest conclusions was that "gases, fluids, electricity, magnetism, ozone, things known or things occult, there is nothing in the air that is conditional to life except the germs it carries." Of his earliest results from experiments on admitting pure air to flasks containing putrescible infusions he wrote: "It seems to me that it can be affirmed that the dusts suspended in atmospheric air are the exclusive origin, the necessary condition of life in infusions"; and in the same paper he made the pregnant remark, "What would be most desirable would be to push those studies far enough to prepare the road for serious research into the region of various diseases." He lived to push his studies into the causes of the silkworm disease, of a cholera which came from Egypt into France, of the plant diseases affecting the manufacture of wine and of beer, of the splenic fever, of the chicken-cholera, and of rabies; and he and his followers invented successful treatment for those diseases, and for the treatment of typhoid fever and diphtheria.

The germ and parasite theory of disease led the way in serum therapy, and established both the philosophy and the practice of the new medicine and surgery of the past thirty-five years. Starting with a sound knowledge of chemistry and physics, and having early acquired a habit of utmost accuracy in observing and reasoning, Pasteur passed over into biological science by the time he was thirty-two years of age, and became the most suggestive and productive inventor and promoter in applied biology that has ever lived. His career illustrates conspicuously the general truth that the sciences most serviceable to mankind during the past sixty years have been the biological sciences. In a letter to his father in 1860, when his inquiries were opening new vistas in physiology, Pasteur wrote:—"God grant that by my persevering labours I may bring a little stone to the frail and ill-assured edifice of our knowledge of those deep mysteries of life and death, where all our intellects have so lamentably failed." That prayer was granted.

Let us review in a summary way the fruits of applied biological science since the nineteenth century opened.

The first invention, vaccination against smallpox, long antedated the later studies of germs, parasites, the routes of disease from one human being to another through insects and other animals, and the theory and practice of immunity. Vaccination, the invention of a country doctor who practised in a dairy district, was a momentous discovery in immunity from a fatal and disfiguring disease, which was frequently epidemic, the immunity being procured by causing in the human body another disease very seldom fatal and not at all disfiguring. The favourable reception and rapid application of Jenner's discovery were due to the fact that many persons at that time protected themselves against the frequent and terrible epidemics of smallpox by being inoculated with smallpox itself. So soon as it was proved that cowpox gave immunity in almost all cases against smallpox, inoculation with cowpox came rapidly into use; because inoculated cowpox proved to be, as one of Jenner's contemporaries remarked, "a pleasanter, shorter, and infinitely more safe disease than inoculated smallpox." The relief of civilised mankind from the terrible recurrent epidemics of smallpox is one of the greatest benefits that the profession of medicine has conferred on the human race.

From biological studies largely on microscopic organisms—protozoa, bacteria, and parasitic growths—the means of communication from one human being to another, or from an animal to man, of dysentery, cholera, typhoid fever, typhus fever, puerperal fever, bubonic plague, diphtheria, tuberculosis, cerebro-spinal meningitis, syphilis, gonorrhœa, sleeping sickness, yellow fever, malaria, and hook-worm disease, have all been brought to light. Means of preventing or restricting the spread of these diseases—with the exception of cerebro-spinal meningitis—have been invented, and for most of them improved methods of treatment have been devised. Much has also been learnt about infantile paralysis, and something about cancer. The whole subject of toxins and antitoxins has been developed with wonderfully beneficent results.

It is really impossible to describe or appreciate the alleviations and preventions of human misery included in this list of the fruits of applied biological science. Some of the diseases mentioned were within a few years familiar household terrors in the most civilised countries, others from time to time destroyed in recurring epidemics large portions of the population in many parts of the world. They terrorised families and

nations, made innumerable homes desolate, and ruined for a time cities and States. The generations now on the stage can scarcely appreciate the formidable apprehensions from which their predecessors suffered, but they themselves have been relieved by the achievements of medical research and preventive medicine. This blessed preventive medicine may almost be said to have been created by the combination of bacteriological and pathological studies, which are all, of course, biological studies. Physiology has been wonderfully developed as a study of biological processes by the addition of bacteriological experimentation to its former chemical and physical methods of research.

Public health boards have been established and equipped to perform under new laws numerous functions which had no existence until applied biology, with aid from chemistry and physics, indicated the desirable modes of public action. The boards, or public health commissioners, prescribe, teach, and enforce rules and orders concerning personal, industrial, farm and dairy, and school hygiene, social hygiene, including venereal prophylaxis, for individuals and families, the preservation of foods and their protection from infection, the effects of various industries on the health of employees, the connection of syphilis with insanity and general paresis, and of gonorrhœa with blindness, procure vital statistics, establish registration of births and deaths, and of cases of disease, study epidemics and infant mortality, and contend against dangerous contagious diseases by quarantine, isolation, disinfection, and the destruction of the insect and vermin carriers of disease. All these activities have been completely dependent on applied biology for their methods and processes, and have changed and developed rapidly with the progress of that science. Taken together, they constitute an immense contribution to human welfare, present and future.

It is animal experimentation with the help of anæsthesia and asepticism which has given mankind by far the larger part of all the exact knowledge of medicine now possessed, and promises still greater serviceableness in the future. In the service of man new studies have been made, not only of microscopic plants and animals, but of many larger creatures which live with man—such as poultry, rabbits, guinea-pigs, cats, dogs, cattle, horses, mules, and monkeys; and of many insects—such as flies, ticks, mosquitoes, and lice, which infest the fauna and flora which surround man, or the bodies or clothes of men themselves. An immense mass of biological information on all these subjects has been accumulating during the past two generations, and is growing rapidly from year to year, as the good results of such studies become better known.

These results bear directly on the well-being and happiness of the human race, but also indirectly on the economic and commercial fortunes of the race. Through the well-directed efforts of the Rockefeller Sanitary Commission hundreds of thousands of persons in the southern States have, within the last five years, been made much more effective labourers, because relieved of the hook-worm disease; and this good work is now being extended by the International Health Commission—one of the departments of the Rockefeller Foundation—to the West Indies, Central America, Ceylon, and the Straits Settlements. The work of this commission has three divisions :—(1) The commission makes surveys of regions where hook-worm disease is prevalent; (2) then it cures multitudes of sufferers by active and persistent treatment; and (3) it teaches people by the thousand how to prevent the recurrence of the disease in farming communities by using privies and wearing shoes. In the last two processes it tries—often successfully—to enlist existing public authorities and the taxing power in the work, in order to give it permanence. All this beneficent action is fruit of biological research. It would have been impossible to dig the Panama Canal without the effective control over yellow fever and malaria which biological science has given to the race within a single generation. Two humane contributions to military efficiency during the great war are results of biological research applied to sanitation, one the prevention of epidemics of fever and cholera in the camps and trenches in western Europe, and the other the quick arrest of a terrible epidemic of typhus fever in Serbia.

Let us next take account of the prospects of applied biology in the coming years. May we anticipate for it an increasing or a decreasing influence?

The progress of medical and surgical research during the past twenty years is of great promise for the future. It goes on actively in every good medical school, in many hospitals and dispensaries, and in the new institutes exclusively devoted to research. It is strongly supported by the new tendency to maintain in medical schools professorships of comparative anatomy, physiology, and pathology. The importance of comparative psychology is just coming to be recognised. Inasmuch as animal experimentation, with the help of anæsthesia and asepticism, is nowadays the principal means of extending knowledge of the causes of disease and of the means of remedy and prevention, the importance of comparative studies on many species of animals, including man, has become obvious to all persons who think about the improvement of the human race and of its useful animal associates.

In regard to the treatment of contagious diseases, the story of the recent past cannot but suggest hopes of even more rapid progress in the future towards the effective control of some of the worst diseases that afflict humanity. Thus, in the ten years from 1903 to 1913, syphilis was transmitted artificially to certain lower animals; the characteristic bacillus of that disease was discovered; the Wasserman test was invented, a test which enables an expert in its use to detect those cases which have no external symptoms; the value of salvarsan, as a safe destroyer of the bacillus within the human body, was demonstrated; and the bacillus was grown in pure culture outside the body, whence resulted luetin, an important aid in the diagnosis of obscure cases; and finally the bacillus was detected in the brain of patients suffering from general paresis, and in the spinal cord of patients with locomotor-ataxy. This series of discoveries and inventions has given to man a much-improved control over this terrible scourge; but this control is not yet applied on an adequate scale. It remains for the future to cause this destructive disease to be early recognised, reported, and dealt with effectively. It is for State and municipal boards of health to invent and put into practice the means of contending against the spread of this horrible disease. This is a public health problem of the gravest sort. That public health authorities may succeed in the future against the horribly destructive effects of syphilis on every civilised race in the world is one of the hopes of the future—a hope inspired by the recent progress of biological science.

The progress of biochemistry and bacteriology has already enabled civilised Governments to do much for the protection of their people from injury by foods not fit for consumption and by adulterated drugs. This is a branch of the public health service which is capable of large extension hereafter. The efficiency of the methods now used will be greatly increased; and they will be used in new fields. It is only about forty years since the Massachusetts Board of Health gave effective

attention to the transportation and slaughtering of animals intended for food, an admirable piece of pioneering which brought about great improvements, and served as a basis for further measures of defence for the community. The common use of cold storage for meats, vegetables, and fruits has lately increased the need of protection against damaged foods; and this cold-storage process is likely to be more and more used in the future—quite legitimately—for the preservation of perishable foods produced in greater quantity than can be sold at or near the time of their production. A cold-storage plant performs as to foods the function of the reservoir in an irrigation plant. Both urban and rural communities have much to hope in the future from cold storage and irrigation; but to both these public utilities applied biological science must contribute indispensable precautions. There are climates in which extensive irrigation is liable to produce and perpetuate pestiferous insects.

One of the most favourable results of applied biology during the past fifty years is the great addition made to the means of detecting the true causes of abnormal conditions within the human body, and to the accuracy of diagnostic reasoning on both acute and chronic disorders. These new means of diagnosis and examination are in part chemical and physical, but chiefly biological. The theory and practice of asepsis are results of biological researches. Comparative anatomy, physiology, and pathology all contribute largely to modern sanitation and to all the practices of boards of health for the discovery and prevention of insanitary conditions in both urban and rural communities. Very promising examples of these useful practices are: the precautions nowadays taken against contagious disease in schools; the employment of school nurses; the inspection of school children's teeth, eyes, noses, ears, and skin; the discovery in the mass of school children of the defective, the feeble-minded, and of those suffering from glandular abnormalities, particularly in the nose, mouth, and throat. The effective treatment of school children following on the detection of their disorders or defects promises much towards the better health of the coming generations. The successful use of the Schick test, which enables the physician through a laboratory expert to separate the susceptible from the non-susceptible individuals who have been exposed to diphtheria, and therefore to avoid all unnecessary administrations of antitoxin, seems to open a wide prospect in the study of natural immunity. The process of improvement is not going to stop; on the contrary, it will advance at an accelerated pace.

Another great field for applied biological science in the future is the contest against alcoholism and sexual vice. This is an important part of the province of social hygiene, a province which includes the philanthropic and economic treatment of the feeble-minded, the insane, the paralysed, and the blind. The field is enormous; and its evils are intimately connected one with another; but in the whole field the means of cure and prevention have come in the main from biological research. There is every reason to expect that this great field for Christian effort will hereafter be more effectually cultivated than it has ever been.

In connection with the medical, surgical, and sanitary activities of the present day, new forms of educational effort have been instituted which are very promising for the future health and comfort of mankind. Thus, the institution of district nursing has already developed strong educational effects. The district nurse goes from house to house to treat and comfort individual patients suffering from various disorders; but in every house she also teaches the mother, sister, or some other attendant on the sick or injured person, how to perform herself the remedial operations, how to feed the patient, and how to prevent the communication of the disease to other persons; and this teaching function of the nurse is quite as important as her curative or comforting ministrations. The social worker who follows up the out-patients of a great hospital, sees them at their homes, studies their surroundings, and gives them sympathetic counsel, has a similar teaching function, which often takes strong effect on whole families and even larger groups. Like the district nurse, she also frequently obtains family histories which are of value to students of inheritance, good or bad, and of eugenics. The same is true of the school nurses and medical inspectors who are employed by American cities in which the health department is strong and well organised. These nurses and doctors not only detect defects and diseases in school children, but indicate to parents or friends the remedial measures that are demanded, and give much instruction to parents and guardians about keeping children well. The same educational function is performed by the dentists who are being employed in a few American cities to make periodical inspections of the teeth of school children. These large-scale examinations and teachings call for acquaintance with bacteriological information and methods only recently acquired, and for skill in the use of diagnostic tools and appliances only recently invented. These new applications of biological science promise great reduction of human suffering and distress, and significant additions to average longevity and average efficiency so soon as they come into general use.

Biological science has made possible several other kinds of widespread teaching which are certain to have beneficial effects on the productiveness of human labour, particularly in agriculture—the fundamental industry. Thus, the whole work of the International Health Commission is essentially educational. It teaches the people in hook-worm disease districts by demonstration, first, that they have the disease; secondly, that it can be cured in the individual and eradicated from the community; and, thirdly, that the embryos of the disease live by thousands in soil that has been befouled by an infected person, and are there ready to infect any person with whose bare, soft skin they come into contact. These demonstrations combined teach the people how the disease may be avoided in the future by an individual or by a community. As a result of this educational work, the common people and the health authorities co-operative effectively in both the work of treatment and that of prevention.

Another illustration of the broad educational processes now at work in consequence of the achievements of applied biology is to be found in the short courses given by many State universities to farmers and their grown-up sons on the principles of agriculture, the choice of seeds, and stock-raising, and in the itinerant teaching for adults now carried on by the U.S. Department of Agriculture throughout the southern States on similar subjects. This instruction is supplemented by the offer of prizes, and the setting-up of model farms, or model acres, in great number as lessons and incitements to neighbourhoods. The effects on the productiveness of American agriculture, especially in cotton and corn, are already remarkable; but the promise of these educational methods for the future is more precious still. Several colleges and universities of high standing now provide short courses which run from six to twelve weeks, some in winter and some in summer, expressly to prepare teachers or leaders for girls' canning clubs and home demonstration work. These courses cover cooking, canning, sewing, market gardening, poultry husbandry, plant propagation, and

rural sanitation. Their good effects have been quickly demonstrated on a large scale.

Boards of health in several American municipalities and States have lately undertaken a large work of public teaching by means of widely distributed posters and leaflets on contagia and the carriers of contagious disease. They have found themselves obliged to take this action, because they learnt by experience that the spread of contagious disease cannot be prevented by enacting laws and employing inspectors to procure the execution of those laws, unless the citizens themselves co-operate actively and with intelligence in the execution of the measures which applied biology prescribes. Thus, the public at large must be taught that if streets, yards, and vacant lots of a city are kept clean, garbage is removed promptly and kept covered until removed, and the privy vault and the manure-heap are abolished, the number of flies and vermin in and about dwellings will be much reduced. Reduction in the amount of sexual vice and venereal disease can be effected by teaching parents and young people about the dangers of syphilis and gonorrhœa for the individual, and their fatal effects on family happiness.

Thirdly, this immense development of biological knowledge and skill must have lessons to teach about the means of other progress, similar or contrasted.

The most important lesson which the great advance in applied biological science teaches is that the treatment of human evils and wrongs in the future should be preventive for the mass, as well as curative for the individual. This is the reason for the great change which is taking place in the profession of medicine. The main functions of that profession are to be, not the curing of individuals who are already suffering from disease, but the prevention of the spread of disease from individual to individual in the community, and the eradication or seclusion of the causes, sources, or carriers of communicable diseases. The same great change needs to be wrought in all the callings which deal with prevention of crimes and misdemeanours. Society must concern itself, not chiefly with the isolation, temporary or permanent, of the individual murderer, thief, or forger, but with the extermination or repair of the genetic, educational, or industrial defects which cause the production of criminals. Since it is often found through medical and psychological examination that the prostitute, forger, robber, or poisoner is physically as well as morally defective, it is probable that biological science will in the future contribute largely to the prevention as well as cure of such bodily defects, and hence of those moral defects which in an appreciable fraction of the population result in crimes. When humane persons learn, for example, that three-fifths of all the prostitutes in New York City are feeble-minded girls and women, they become interested at once in the better care and treatment under medical dirction of the feeble-minded, in the means of making a trustworthy diagnosis of feeble-mindedness in children, and in preventing the feeble-minded from reproducing their like. These are all biological problems; and the progress of biological inquiry during the past fifty years is sufficient to afford the means of solving on a large scale these fundamental social problems. It is to biological science in the departments of mental disease and psycho-therapy, as well as to educational theory and practice, that we must look for new methods of discipline and education in prisons, reformatories, and houses of correction. Preventive medicine and sanitary reform have shown the right way of dealing with these chronic sores in the body politic.

The interrelations of the sciences are vividly taught by the history of biology during the past eighty years. Biological science is deeply indebted to physical science for the new instruments of precision which the biologist uses in determining and recording his facts. The telephone, the X-ray, and all the electrical apparatus for recording fluent observations and making certain note of very minute portions of time and space have been invaluable additions to the resources of the biological investigator. Many of the instruments which are indispensable in botanical and zoological laboratories were not invented for biological uses, but for physical or chemical uses. The dental practice called orthodontia has profited greatly by the use of the X-rays, because the Röntgenograph exhibits the precise abnormalities in the jaws and the concealed teeth which need to be remedied. The art of photography has contributed much to biological research and biological teaching, although developed and improved more for commercial and astronomical purposes than for biological. The microscope itself and the immersion lens, tools indispensable in the study of micro-organisms of all sorts, were long used in pure botany and zoology, before they became the necessary tools of applied biological science.

Again, the long series of successful applications of biological science illustrates strikingly the impossibility of drawing any fixed line of demarcation between pure and applied science, or of establishing an invariable precedence for one over the other. Sometimes an application is suddenly made of one fragment of an accumulation of knowledge which men of science have made without thought of any application, and sometimes a bit of knowledge successfully applied stimulates purely scientific workers to enter and ransack the field from which the bit came. The latter process was strikingly illustrated when the large group of the mosquitoes were studied with ardour, because two species became famous, one as the carrier of malaria, and the other of yellow fever. The anatomy and habits of the typhus fever louse had been worked out many years before that insect became known as a carrier of typhus fever. Long before salvarsan was proved valuable for killing the syphilis micro-organism in the human body, a series of organic compounds derived from benzol and containing arsenic had been elaborately studied, and the means of producing them made known by chemists who had not the faintest suspicion that a safe remedy for the most destructive of contagious diseases in the human species was later to be found in a new member of the series having a reduced arsenical potency. The man of science often feels, and not infrequently expresses, contempt for applications of science and for the men that make them. Sometimes the seeker for valuable applications of scientific knowledge feels no interest whatever in researches of which no industrial application seems feasible or probable, and confesses publicly this lack of interest. The facts seem to be that all such feelings are narrow and irrational; that no mortal can tell how soon a practical application of a scientific truth, which seems pure in the sense that it has no present application, may be discovered; and that, on the other hand, innumerable applications are nowadays made of truths which five years or fifty years ago seemed as remote from all human interests as the observation attributed to Thales, that a bit of amber rubbed with a piece of silk would repel pith-balls suspended by fine filaments. Yet all magnetism and electricity with their infinite applications hark back to this experiment by Thales and to Galvani's observation of twitchings in a frog's legs.

The new physiological studies of the bodily changes accompanying or produced by pain, hunger, fear, and rage already promise a new interpretation of human behaviour, and therefore a new policy for human

society in regard to those emotions which, from primitive times to the present day, have been the source of enormous evils to mankind. The bodily changes which in man accompany these powerful emotions have only recently been in part made known; but it has already been made out with regard to a group of these alterations in the bodily economy that they may be regarded as responses adapted to preserve the individual, and to promote his bodily welfare or his efficiency. The emotions which man fighting experiences call into sudden and potent action the muscular and nervous forces which he needs for both offence and defence. Hunger is a highly protective sensation. Fear stimulates muscular and nervous exertion, so long as the frightened animal can flee; but, if the animal is cornered, fear turns to fury, which develops the extraordinary strength of desperation. The successful study to-day of these bodily changes and reactions prophesies a better understanding in the future of the moral forces which make for rational conduct, and of the public policies in regard to war and peace which, long pursued, may gradually affect the sum of human misery or of human happiness.

The present terrible condition of Europe, and the coincident sufferings of much of the rest of the world, give fresh significance to the following remarks of Louis Pasteur at the inauguration of the Pasteur Institute at Paris in 1888:—"Two contrary laws seem to be wrestling with each other nowadays—the one a law of blood and of death, ever imagining new means of destruction, and forcing nations to be constantly ready for the battlefield; the other a law of peace, work, and health, ever evolving new means of delivering man from the scourges which beset him. The one seeks violent conquests; the other the relief of humanity. The latter places one human life above any victory, while the former would sacrifice hundreds and thousands of lives to the ambition of one. . . . Which of these two laws will ultimately prevail, God alone knows."

The whole civilised world observes with delight that the profession of medicine, including surgery and the profession of public health and sanitation, stands out distinctly among all the intellectual callings as being steadily and universally devoted to curing the sanguinary ills of war, alleviating human sufferings from disease and folly, and extending for mankind the domain of health and happy life. These professions employ all the resources of physics, chemistry, and biology for merciful ends, both in peace and in war. The martial professions, on the other hand, employ many scientific discoveries and inventions, originally made for peaceful uses, as means of destruction and death. Biological science has great advantage in this respect over physical and chemical. It cannot so frequently or easily be applied to evil ends.

The development of public sanitation practice during the past fifty years has taught democratic communities important lessons on the just subordination of individual interests or rights to collective interests or rights, whenever the fulfilment of individual desires imperils the collective security. Sanitary regulations often interfere with family management, the schooling of children, the transportation and selling of perishable goods, the established practices of mining and manufacturing corporations and of small tradesmen, and even the personal habits of the private citizen. These interferences are sometimes abrupt and arbitrary. On the whole, however, this teaching has been wholesome in the freedom-loving nations, in which individualism is apt to be exaggerated, and the sense of neighbourliness and social unity needs to be quickened.

The rapid development of public sanitation has also given important lessons on promptly utilising so much as we know of applied science, but also modifying our practices rapidly whenever the subsidiary sciences effect an advance. Forty years ago the filth and fomites theory was the basis of sanitary practice. Municipal and household cleanliness are still inculcated, but the emphasis on them is no longer exclusive. Then, bacteria and other disease-producing organisms became the chief objects of interest for sanitarians, and sanitary practice was based on knowledge of these organisms, and study of the media through which they reached man, such as the air, water, the soil, dust, milk, and other uncooked foods. Isolation of all cases of contagious disease was much insisted on. Isolation is still useful in many cases; but it is not regarded to-day as the one effectual defence against epidemics and the diffusion of disease. Next, insect and vermin carriers were made known, and with them came in quite a new set of sanitary practices—not a replacement but a large addition. Lastly; the contact theory of contagion, with its demonstrations that living bacteria may be carried from one person to another in minute vesicles or droplets thrown off in coughing, sneezing, or any convulsive effort, and borne on the air, has gained general acceptance. At the same time, abundant proof has been given that pathogenic bacteria and protozoa develop in the bodies of many persons without causing any recognisable symptoms. Yet the virulence of the germs these persons carry may be extreme.

These recent discoveries have introduced serious difficulties into some departments of sanitary practice. The apparently healthy carrier cannot be isolated, for he remains unknown. If at any time such carriers and missed cases are numerous in a given community, isolation becomes useless, if not impossible. That is the ordinary condition of most American communities in regard to tuberculosis. Hence, bacteriologists have before them a very useful piece of work in the study of human carriers of disease who are not sick. Meantime sanitary practice is obtaining sound explanations of the occasional failure of its former methods of resisting epidemics, and preventing the spread of the ordinary contagious diseases.

The principal lesson to be drawn from the experiences of sanitarians during the past fifty years is that practitioners of any useful art must be prompt at every stage of progress to make use of knowledge just attained, even if it be empirical and incomplete, and must not linger content or satisfied at any stage. This lesson is applicable in every modern industry and educational or governmental agency during either peace or war.

Biologists are now realising that biochemistry must furnish the fundamental knowledge of the processes which incessantly go on in the healthy body, and must also provide the exact knowledge of those changes in the normal processes which lead to disease and death. The physician and the sanitarian have become accustomed to the beneficial use of remedies and defences which chemistry at present can neither analyse nor synthesise, such, for example, as diphtheria antitoxin; but they are aware that this condition of their art is unsatisfactory and ought not to be permanent. The animal body consists of well-known chemical substances, and its functions depend on chemical reactions. Digestion is largely a chemical process. The animal body consists of innumerable cells in great variety, each of which acts under chemical and physical laws. Hence the belief of the biologist of to-day that chemistry—analytical, structural, and physical—can and will come to the aid of the science and art of medicine in the large sense, and will ultimately enable biological science to comprehend the vital processes in health and disease, and to penetrate what are now the secrets of life and death.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The number of undergraduates in residence this term is 665, as against 1227 during the corresponding term last year, and about 3600 in a normal term. Amongst the 11,000 members of the University in the land, sea, and air services, 1723 casualties have been notified; 697 have been killed and 892 wounded. The Victoria Cross has been awarded to three Cambridge men, the D.S.O. to 52, and the Military Cross to 103; the services of 714 members of the University have been recognised. Owing to the small number of undergraduates in residence a considerable amount of distress prevails amongst the keepers of licensed lodgings, some 1500 in number, and it has been suggested that munition workers might be economically housed in the vacant quarters; several large empty buildings are available which might be converted into munition factories. The late Rev. Dr. Streame left the sum of 500*l.* to Corpus Christi College, to be used as the master and fellows shall determine.

LONDON.—Owing to circumstances arising out of the war, Mr. Kilburn Scott's course of lectures on "Electrical Production of Nitrates for Fertilisers and Explosives," announced to begin at University College yesterday, January 26, will not be held.

SIR G. H. MAKINS has been appointed to deliver the Hunterian oration of the Royal College of Surgeons of England in 1917.

DR. F. E. BRASCH contributes to *Science* (vol. xlii., No. 1091, p. 746) an interesting article on the teaching of the history of science in American universities and technical schools. The nineteenth century was too full of creative work in the various fields of science to give historical studies their full play. The new century, on the other hand, will offer a larger field for historical studies for the reason that the practical value of such work will be more clearly demonstrated. There is a growing tendency to depart from the extreme and powerful method of specialisation, and to teach science from an historical point of view. An interesting statistical study is made of the courses in the history of the different sciences offered in universities and technical schools. These courses are on the whole specific to the individual sciences, and general courses of science history are of late origin, and exist only in a few schools. There is, however, no doubt that there is a growing tendency to regard the historical development of the sciences from a broader point of view than was possible or practicable in earlier years.

A MEETING of delegates from London branches of the Workers' Educational Association and similar organisations in the London County Council area was held on January 22 at the Memorial Hall, Farringdon Street, to discuss the proposal of the L.C.C. Education Committee to save 300,000*l.* on the educational expenditure for the year. A resolution was carried declaring that the policy of "educational reaction" adopted by the London County Council was opposed to the true interests of the workers and the nation as a whole, and calling on the Workers' Educational Association to work continually for the improvement of the educational service of the County of London. The Rev. William Temple, president of the association, in his speech from the chair, said that the meeting had been called because of the fear that the example of London might be followed elsewhere. Members of their association were much more concerned about this action as a symptom than about the actual fact, and their primary concern must be to convince public authorities that if they desired to represent the people they must put education in the forefront and prevent the war from being used as an occasion for whittling away that small amount of education which years of struggle had secured for children who without it would never be able to take their proper place in the life of the nation.

SOCIETIES AND ACADEMIES.

LONDON.

Mineralogical Society, January 18.—W. Barlow, president, in the chair.—Prof. G. **Cesàro**: A simple demonstration of the law of Miller. In any spherical triangle the arc x joining the apex C to a pole dividing the base c into segments a and β is given by the equation $\cos x \cos c = \cos a \sin \beta + \cos b \sin a$. Taking the apex as the pole of one of the axes and the base as the zone containing the four poles, the usual anharmonic ratio is obtained.—Dr. G. T. **Prior**: The meteorite of Daniels Kuil. The meteorite consists of nickeliferous iron in large amounts, troilite, oldhamite, felspar, and enstatite, free from iron, and thus belongs to the exceptional Hvittis and Pillistfer group of chondritic stones, to which also must be added the Khairpur meteorite, which contains notable amounts of oldhamite.—Dr. G. T. **Prior**: The relationship of meteorites. Meteorites may be arranged by their chemical and mineral composition into the following six groups: (1) Bustee and Hvittis group; (2) Siderolites; (3) Cronstad group, consisting of chondrites, containing more than 10 per cent. of nickeliferous iron; (4) Baroti group, consisting of chondrites containing less than 10 per cent. of nickeliferous iron; (5) Chladnite group, including Chladnites, Angrites, Chassignites, Amphoterites, some Rodites, and probably some chondrites containing little nickeliferous iron; (6) Eucrites, Nakhlites, Shergottites, Howardites, and some Rodites. It is suggested that from the first group the remaining stones have been derived by the interaction between oxidising nickeliferous iron and enstatite with consequent production of ferriferous olivine and bronzite, the formation of chondrules, and enrichment in nickel of the residual iron. The nickeliferous iron of the first three groups corresponds with the more common meteoric irons, such as the octahedrites and hexahedrites, containing less than 10 per cent. of nickel, and that of the last three to nickel-rich ataxites, containing more than 10 per cent. of nickel. The groups (2) to (6) contain progressively diminishing amounts of nickeliferous iron, which is increasingly rich in nickel, and have increasing amounts of ferrous oxide in the ferromagnesium silicates, in which the ratio of magnesium to iron atoms approximates in the case of group (2) to 7, of group (3) to 5, of group (4) to $3\frac{1}{2}$, of group (5) to 2, and of the last group to 1 or less.—Dr. J. W. **Evans**: The isolation of the directions-image of a section of a mineral in a rock-slice. In some optical investigations, *e.g.*, the observation of the interference figures of minerals in thin sections under the microscope, the determination of the angle of total reflection, and the measurement of crystal angles, the image studied is not that of the object, but is one in which every part corresponds to a direction in which light is transmitted, or, in other words, it is a directions-image. To prevent the effects of closely adjoining objects being blended, all light except that traversing the object under investigation must be screened by a diaphragm placed near it or in a position conjugate with it. In an ordinary petrological microscope this may often be conveniently effected by placing the diaphragm below the condenser so that the image of the aperture is seen in focus simultaneously with that

of the object. The best results are, however, obtained when the diaphragm is placed in the focus of the eyepiece, and, after it has been adjusted, the Becke lens placed above it. The same method may be employed with advantage in the other observations referred to, the instrument employed being constructed primarily as a microscope and converted into a telescope by the addition of a lens, instead of *vice versâ*, as is the usual procedure.—Dr. J. W. **Evans**: A new method of determining the angular direction represented by a point in the directions-image. A circular plate is ruled with concentric circles at distances from the centre equal to $r \tan \theta$, where θ stands for different angles at intervals of 5° up to the full aperture of the objective, and r as a constant length, say, 50 mm., and with radiating lines 5° apart; it may be placed on supports which fix its position above the stage. When the microscope is adjusted for observations of the directions-image of a mineral, the point the angular position of which is to be determined is identified by the end of an adjustable pointer, which is placed so as to be seen in focus. The microscope is then focused up until the objective is accurately at a distance r from the plate, which is now placed in position and is clearly seen. The angular position required is then shown by the position of the end of the pointer relatively to the scale on the plate.—L. J. **Spencer**: A new (seventh) list of mineral names.

Institution of Mining and Metallurgy, January 20.—Sir Thomas Kirke Rose, president, in the chair.—W. F. **Collins**: Chinese mining legislation. The important consequences that may result from the introduction of a more suitable code of laws regulating mining conditions than that now in force can be appreciated when it is realised that China claims sovereignty over 4½ million square miles of territory, and that if her mining development were on a par with that of the United States, the mines should give employment to nearly fifteen million men, pay wages of nearly 200 million pounds per annum, and produce in State revenue on a royalty of 2½ per cent. a sum of at least ten million pounds annually, apart from further duties levied by the Maritime Customs. Apparently the awakening of China which is now in course of progress will affect its mining industry amongst others, and the provision of legislation to deal with the changed outlook on affairs cannot be long delayed. The author of this paper passes in review the gradual evolution of mining legislation in China from the earliest times up to the present day, and seeks to show where it has proved prejudicial to proper development, and he then proceeds to formulate such changes as in his opinion will tend to attract foreign capital for the carrying on of the industry. He points out that the existing regulations place a foreigner at a serious disadvantage in competition with Chinese mining companies, and that it may be taken as axiomatic that so long as foreign capital is unable to work mines in China under its own company law, it will prefer to interest itself elsewhere. His criticism is constructive to the extent that he enunciates the fundamental principles required to be drafted into new mining legislation before the desired influx of foreign capital can be converted into an accomplished fact.—W. H. **Trewartha-James**: Taylor's pulp sampler. In this paper the author describes briefly an automatic pulp sampler of simple design and construction which has already, he claims, accomplished much useful work in Cornish tin mines. The apparatus provides for cutting the stream of pulp automatically at fixed intervals, which can be adjusted over a wide range, so obtaining samples in desired proportion to the amount of material passing through the feed launder. The inventor of the device has presented his design to the mining industry through the medium of the institution, and it has the advantage that it can easily and cheaply be constructed out of materials found in nearly every mine store, by an ordinary workman.

MANCHESTER.

Literary and Philosophical Society, December 14, 1915.—Prof. S. J. Hickson, president, in the chair.—F. G. **Percival**: The punctuation of the Brachiopoda. The shells of the Terebratulaceæ are perforated by thousands of little pores, through which pass tube-like processes of the mantle. The number of these punctæ per sq. mm. varies in different species, and this variation has been used as a means of distinguishing between different species. Unfortunately, an examination of large numbers of individuals belonging to one species shows that the variation within a single species is so great as to render the character useless as a means of distinction, *e.g.* 166 individuals of *Terebratula biplicata*, Brocchi, were examined and found to range from 39 to 129 per sq. mm. Similarly, 367 specimens of *T. punctata*, Sow., showed a total range from 66 to 240 per sq. mm. All the readings were taken at approximately the same distance from the umbo, because the number per sq. mm. increases with the distance from the umbo. These two species alone cover the greater part of the total variation possible for the group, and the variation in number is therefore almost useless as a means of specific distinction.—J. W. **Jackson**: The money cowry as a sacred object among North American Indians. One of the chief objects of value used at religious ceremonies by the Ojibwa and Menonimi Indians is the money cowry, *Cypraea moneta*. The use of this particular species is of great interest by reason of it being alien to the American continent, and in view of its adoption for religious and other purposes in the Old World. In the cult of Venus cowries played an important part in ancient times in European countries. The tradition among the Indians is that the sacred shell came through a particular hero-god, who acted as intermediary between the Great Unknown and the Indians, and founded their medicine society. During initiation ceremonies the candidate is acquainted with the traditions pertaining to cosmogony and to the genius of the Indians; much dancing and smoking is indulged in, and the medicine bag containing the sacred shell is thrust towards the candidate, by which means the shell—the symbol of life—is supposed to enter the latter's breast.—J. W. **Jackson**: The Aztec moon-cult and its relation to the chank-cult of India. The similarity in the use of shells in Aztec and Hindu religious ceremonies is remarkable, and several striking instances occur on Aztec manuscripts, where large conch-shells are seen in use as trumpets and marine shells are figured as symbols of the moon. The adoption of a shell as the emblem of the Mexican moon-god recalls the association of the chank-shell with the Hindu god Vishnu. This parallel is even more striking when one considers that the Brahman in reciting his daily prayer begins by a reference to the god of the moon at the mouth of the chank which he holds. Shell trumpets are used in India in connection with temple-worship and with harvest rites, and a like procedure is to be seen on the old Mexican picture-writings. Further, the ancient Mexicans, like the Hindus, had the same myth regarding the presence of a rabbit in the moon.—Prof. G. Elliot **Smith**: Further evidence for the derivation of elements of early American civilisation from the Old World. Discussing the significance of pre-Columbian representatives of the elephant in American sculptures and codices (already summarised in NATURE, November 25, p. 340, and December 16, p. 425), and making use of the evidence supplied by truncated pyramids

and the winged-disc symbolism in substantiation of the influence of Egypt and Asia, attention was directed to the fact that a great part of the ancient Indian pantheon, centred around the god Indra, had been bodily adopted by the Maya people of Central America. Evidence was adduced to explain the details of the process of transmission (which probably began somewhere about 200 B.C., and continued for many centuries), and the confusion which was introduced during the migration. Particular attention was directed to the great influence exerted by the late conventionalised form of the Indian Makara, as a sea-elephant, in determining the design, not only of the Copan elephants in the far east, but also of the early Christian and pre-Christian representations of the elephant upon the sculptured stones of Scotland and Scandinavia in the far west. The fact was again emphasised that practically every element of the early civilisations of America was borrowed from the Old World. Small groups of immigrants from time to time brought to America certain of the customs, beliefs, and inventions of the Mediterranean area, Egypt, Ethiopia, Arabia, Babylonia, India, Indonesia, eastern Asia, and Oceania, and this confused jumble of practices became assimilated and "Americanised" in their new home across the Pacific, as the result of the domination of the great uncultured aboriginal populations by small bands of more cultured foreigners.

January 11.—Presidential address.—Prof. S. J. **Hickson**: Animal symmetry and the differentiation of species. The attempt made by Cuvier, at the beginning of the nineteenth century, to separate into one division of the animal kingdom—the Radiata—all those forms of animal life that show a radial symmetry from the other divisions that included animals with a bilateral symmetry never met with much success. The advance of knowledge has shown that these symmetries cannot be used as a basis of classification. But it is worth while to consider the conditions which led to the development of the radial symmetry of the organs in some animals, and the bilateral symmetry of the organs in others. Radially symmetrical animals are usually sedentary or floating in habit, and have a feebly developed muscular system. Bilaterally symmetrical animals, on the other hand, have usually the power of moving rapidly and powerfully from place to place, and are provided with a well-developed muscular system. Nearly all the radially symmetrical animals show considerable variability even as regards the number and disposition of important organs. In bilaterally symmetrical animals, on the other hand, there is far less variability in important organs. In consequence of this difference in variability of the two kinds of animals, the systematic zoologist finds greater difficulty in arranging the former into discontinuous specific groups than the latter; and it may be a question for consideration whether in radially symmetrical animals we find any such discontinuity as that indicated by the species of bilaterally symmetrical animals. In the Pennatulacea we have a group of animal colonies which show a series of stages from radial symmetry to bilateral symmetry. In the radially symmetrical forms there is very great variability in all the important features of the colony, and definite discontinuity between specific groups is difficult to find. In the bilaterally symmetrical Pennatulacea, however, variability in these features is greatly reduced, and definite species are more clearly disclosed.

PARIS.

Academy of Sciences, January 10.—M. Camille Jordan in the chair.—Gaston **Darboux**: An extension of Poncelet's theorems relating to polygons inscribed in, or circumscribed about, conics.—G. **Bigourdan**: The manuscripts of the works of Jean de Lignières. A continuation of a catalogue commenced in an earlier communication, including MSS. at Erfurt, Florence, London, Melk, Milan, Munich, Oxford, Padua, Paris, Prague, and Rome.—G. **Humbert**: The convergents of Hermite.—D. **Eginitis**: Observations of Mellish's comet (1915*a*) made at the Athens Observatory with the Doridis equatorial (Gautier 40 cm.) Positions given for September 17 and 18, November 13, 15, 16, and 17.—G. A. **Le Roy**: The preservation of solutions of sodium aluminate by cold. At ordinary temperatures solutions of sodium aluminate are unstable, depositing alumina. At a temperature of $-1°$ C. to $-2°$ C. no change in composition was found after one month.—MM. **Russo** and **Tussau**: Geological journeys through Central Morocco.—Alfred **Angot**: Value of the magnetic elements at the Observatory of Val-Joyeux on January 1, 1916.—O. **Lignier** and Adr. **Toison**: Ephedra possessing a closed ovary and an included ovule.—M. **Pontio**: The analysis of textiles. A modification of the Vétillard method of microscopical examination.—Robert **Lévy**: The toxins of Epeira and Tegenaria.—E. **Gley** and Alf. **Quinquaud**: The relations between the secretion of the suprarenals and the vasomotor function of the splanchnic nerve. Contrary to the generally accepted view, from the experiments described it would appear that the stimulation of the splanchnic vasomotor arises from a neuro-muscular action and does not produce its effect by the intermediary of the adrenalin secretion.—M. **Cazin** and Mlle. S. **Krongold**: The methodical use of antiseptics based on the bacteriological examination of the pus in the treatment of septic wounds. Regular bacteriological examination of the pus is necessary, with corresponding change in the antiseptic solution, for the successful treatment of infected wounds. Wounds containing the pyocyanic bacillus, or in which staphylococci predominate, are best treated with a 1 in 200,000 silver nitrate solution. Gangrenous wounds containing *Bacillus perfringens* or the septic vibrion are best treated with weak solutions of sodium hypochlorite. In very weak solutions its prolonged use does not cause irritation, and the bactericidal power is not greatly affected by high dilution. The serum of Leclainche and Vallée can be used with advantage when streptococci are present.—MM. **Santamaria** and **Salonne**: Apparatus for the reduction of simple or compound fractures of the eight segments of the limbs. —E. **Vasticar**: The terminations of the acoustic nerve. M. **Delphy**: A remarkable deformation of the mouth of a specimen of *Trigla gurnardus*.

BOOKS RECEIVED.

Board of Agriculture and Fisheries. Fishery Investigations. Series ii.: Sea Fisheries. Vol. ii., No. 2, pp. 79. Vol. ii., No. 4, pp. 18+8 plates. Vol. ii., No. 5, pp. 34. (London: H.M.S.O.: Wyman and Sons, Ltd.) 5*s*., 4*s*., and 1*s*. respectively.

An Elementary Manual of Radiotelegraphy and Radiotelephony for Students and Operators. By Prof. J. A. Fleming. Third edition. Pp. xiv+360. (London: Longmans and Co.) 7*s*. 6*d*. net.

Neolithic Dew-Ponds and Cattleways. By Dr. A. J. Hubbard and G. Hubbard. Third edition. Pp. xxiv+116. (London: Longmans and Co.) 4*s*. 6*d*. net.

Water Purification Plants and their Operation. By M. F. Stein. Pp. viii+258. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 10*s*. 6*d*. net.

Annuaire pour l'an 1916 publie par le Bureau des Longitudes. Pp. vi+502. (Paris: Gauthier-Villars et Cie.) 1.50 francs.

A Concordance to the Poems of Edmund Spenser. Compiled and edited by Prof. C. G. Osgood. Pp. xiii+997. (Washington: Carnegie Institution.)

History of Domestic and Foreign Commerce of the United States. By E. R. Johnson, T. W. van Metre, G. G. Huebner, and D. S. Hanchett. Vol. i., pp. xv+363. Vol. ii., pp. ix+398. (Washington: Carnegie Institution.)

The Physiology of the New-born Infant: Character and Amount of the Katabolism. By F. G. Benedict and F. B. Talbot. Pp. 126. (Washington: Carnegie Institution.)

The Feebly Inhibited, Nomdism, or the Wandering Impulse, with Special Reference to Heredity. Inheritance of Temperament. By C. B. Davenport. Pp. 158. (Washington: Carnegie Institution.)

The Vegetation of a Desert Mountain Range as conditioned by Climatic Factors. By F. Shreve. Pp. 112+36 plates. (Washington: Carnegie Institution.)

Experiments with Displacement Interferometer. By Prof. C. Barus. Pp. vi+113. (Washington: Carnegie Institution.)

Bartholomew's War Map of Central Africa. (Edinburgh: J. Bartholomew and Co.) 2s. 6d. net.

Sleeping Sickness: a Record of Four Years' War against it in the Island of Principe, Portuguese West Africa. By B. F. Bruto da Costa, J. F. Sant' Anna, A. C. dos Santos, and M. G. de Araujo Alvares. Translated by Lieut.-Col. J. A. Wyllie. Pp. xii+260. (London: Baillière, Tindall, and Cox.) 7s. 6d. net.

Transactions of the Royal Society of Victoria. Vol. vi., 1914. Dioptrographic Tracings in Three Normæ of Ninety Australian Aboriginal Crania. By Prof. J. A. Berry and Dr. A. W. D. Robertson. Pp. 6+270 plates. (Melbourne: A. J. Mullett.)

Civilization and Climate. By E. Huntington. Pp. xii+333. (New Haven: Yale University Press; London: Oxford University Press.) 10s. 6d. net.

Organic Chemistry, or Chemistry of the Carbon Compounds. By V. von Richter. Edited by Prof. R. Anschütz and Prof. G. Schroeter. Vol. i. Chemistry of the Aliphatic Series. Translated and revised by Prof. P. E. Spielmann. Pp. xvi+719. (London: Kegan Paul and Co., Ltd.) 21s. net.

Bitter Pit Investigation: The Experimental Results in their relation to Bitter Pit and a General Summary of the Investigation. Fourth Report, 1914–15. By D. McAlpine. Pp. 178+xl plates. (Melbourne: A. J. Mullett.)

Historia del Observatorio de Manila, 1865–1915. By R. P. M. S. Maso. Pp. 210. (Manila: E. C. McCullaugh and Co., Inc.)

Physical Chemistry for Schools. By Dr. H. J. H. Fenton. Pp. viii+215. (Cambridge: At the University Press.) 3s. 6d. net.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 27.

ROYAL SOCIETY, at 4.30.—A Collision Predictor: Prof. J. Joly.—Discussion of Kew Magnetic Data, especially the Diurnal Irregularities of Horizontal Force and Vertical Force, from ordinary days of the eleven years 1890 to 1900: Dr. C. Chree.—A Portable Variometer for Magnetic Surveying: G. W. Walker.—The Single Line Spectrum of Magnesium and other Metals and their Ionising Potentials: Prof. J. C. McLennan.—The Microscopic Structure of Semipermeable Membranes, and the Part Played by Surface Forces in Osmosis: F. Tinker.—The Reduction of Metallic Oxides with Hydrogen at High Pressures: E. Newbery and J. N. Pring.—Discontinuous Fluid Motion Past a Curved Boundary: H. Levy.

ROYAL INSTITUTION, at 3.—Fuel Economy from a National Standpoint: Prof. W. A. Bone.

FRIDAY, JANUARY 28.

ROYAL INSTITUTION, at 5.30.—The Science of Clothing and the Prevention of Trench Feet: Dr. Leonard Hill.

PHYSICAL SOCIETY, at 5.—Guthrie Lecture: Some Problems of Living Matter: W. B. Hardy.

SATURDAY, JANUARY 29.

ESSEX FIELD CLUB (at the Essex Museum, Stratford), at 3.—Fresh-water Polyzoa, Illustrated by Specimens: J. Wilson.—Recent Roman Discoveries in London: F. Lambert.

TUESDAY, FEBRUARY 1.

ROYAL INSTITUTION, at 3.—The Physiology of Anger and Fear: Prof. C. S. Sherrington.

RÖNTGEN SOCIETY, at 8.15.

WEDNESDAY, FEBRUARY 2.

SOCIETY OF PUBLIC ANALYSTS, at 8.—Annual General Meeting.—Note on Human Milk: G. D. Elsdon.—Notes on Common Processes used in Water Analysis: W. T. Burgess.—Poli Oil—A New Adulterant of Ghee: J. H. Barnes and Arjan Singh.

GEOLOGICAL SOCIETY, at 5.30.

ROYAL SOCIETY OF ARTS, at 4.30.—Women's Work During and After the War: Hon. Lady Parsons.

ENTOMOLOGICAL SOCIETY, at 8.—The Pairing of the Plebeiid Blue Butterflies: Dr. T. A. Chapman.

THURSDAY, FEBRUARY 3.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* Note on an Orderly Dissimilarity in Inheritance from Different Parts of a Plant: Prof. W. Bateson and C. Pellew.—Observations on Coprozoic Flagellates, together with a Suggestion as to the Significance of the Kinetonucleus in the Pinucleata: H. M. Woodcock.—Investigations dealing with the Phenomena of Clot Formations. III. Further Investigations of the Cholate Gel: S. B. Schryver.—The Mechanism of Chemical Temperature Regulation: J. M. O'Connor.

ROYAL INSTITUTION, at 3.—Industrial Applications of Gaseous Fuels derived from Coal: Prof. W. A. Bone.

FRIDAY, FEBRUARY 4.

ROYAL INSTITUTION, at 5.30.—Fifteen Years of Mendelism: Prof. W. Bateson.

GEOLOGISTS' ASSOCIATION, at 8.—Presidential Address: The Geological History of Flying Invertebrates: G. W. Young.

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THURSDAY, FEBRUARY 3, 1916.

INDIAN LOCAL FLORAS.

The Flora of the Nilgiri and Pulney Hill-tops (above 6500 feet), being the Wild and Commoner introduced Flowering Plants round the Hill-stations of Ootacamund, Kotagiri, and Kodaikanal. By Prof. P. F. Fyson. 2 vols. Vol i., pp. xxvi+475. Vol. ii., 286 illustrations. (Madras: The Superintendent, Government Press; London: Thacker and Co., 1915.) Price 10 rupees or 15s. 2 vols.

THE need for guides to the plants of particular Indian districts has been felt since English rule was established in the East. The wish to meet it, perhaps stimulated by the posthumous publication of Roxburgh's "Flora Indica" in 1832, led to the preparation of Graham's Bombay "Catalogue" in 1839, of Munro's "Hortus Agrensis" in 1844, and of Voigt's "Hortus Calcuttensis" in 1845. The appearance in 1855 of that fine fragment, the "Flora Indica" of Hooker and Thomson, led to Sir W. Elliot's "Flora Andhrica" for Madras, of which the only part was issued in 1859, and to Dalzell and Gibson's "Bombay Flora," published in 1861. In 1872 Sir Joseph Hooker commenced as an official undertaking his masterly "Flora of British India." After this date, except as regards Bombay, the requirements of forest officers involved the provision of Beddome's Madras "Flora Sylvatica" and Brandis's "Forest Flora of North-west and Central India" in 1874, Kurz's "Forest Flora of British Burma" in 1877, and Gamble's "List of the Trees, etc., of the Darjeeling District" in 1878. With these exceptions, between 1872 and 1897, when the last volume of Hooker's "Flora" appeared, the energies of Indian botanists were directed to assisting that author in his arduous task.

The official scheme involved the preparation, using Hooker's pioneer work as a basis, of local floras of Bombay, Madras, the Panjab, Upper and Central India, Bengal, the North-west Himalaya, the Eastern Himalaya, Assam, and Burma. These provincial floras were in turn to serve as the foundation, where required, of floras of still narrower areas. The necessary local flora of Bengal was completed in 1903; that of Bombay in 1908; that for Upper and Central India, begun in 1903, is nearly complete; that for Madras is in hand and has made considerable progress. Delays have attended the preparation of those for the Panjab and the North-west Himalaya; the time is not yet ripe for those of the Eastern Himalaya, Assam, or Burma. Based on the Bengal work, divisional or district floras of Chutia Nagpur and the Sundribuns have been issued; similar works for Central India and Dehra Dun, the district in which the Imperial Forest School is situated, have been based on that for Upper India.

India is a country where public officers aim at efficiency; the letter is never there permitted to kill the spirit of a prescribed programme. Hence the appearance in 1902 of Sir Henry Collett's "Flora Simlensis" for a North-west Himalayan district, before the preparation of the corresponding provincial flora could be undertaken, and the appearance now of a similar work by Prof. Fyson for a South Indian district, before the Madras local flora has been completed. The justification in both cases is the same and is ample. The Palnis and the Nilgiris, like the Simla hills, are holiday resorts, the visitors to which during vacation leisure take an intelligent interest in natural objects and desire to learn something of what they see.

The area dealt with by Prof. Fyson is not a continuous one and, apart from this, does not lend itself readily to physiographical delimitation. The author has therefore wisely confined his attention to the constituents of the relatively temperate and herbaceous vegetation met with above the level of 6500 feet, where there is a rapid, if not abrupt, change from the tropical and sub-tropical arborescent flora lower down, rather than endeavoured to include every species that occurs within a definitely circumscribed area. His descriptions are clear and full, and his field experience has led him to deal not only with species that may be regarded as indigenous, but with those that have almost certainly been introduced. How important the introduced element in his area is we gather from the fact that one-seventh of the species dealt with are thoroughly established aliens.

As in the case of the corresponding work for Simla, illustrations of a considerable number of the Nilgiri and Palni plants described by the author are provided. For the original drawings he has been particularly indebted to Lady Bourne, herself for many years a close and critical student of the vegetation of the Palnis; a number of the illustrations are by Mrs. Harrison and Mrs. Fyson. In order to secure most of the others, Prof. Fyson has successfully adopted the method of Roxburgh at the close of the eighteenth century and of Wight in the earlier half of last century, by enlisting the services of a skilful young Indian artist. The result has been satisfactory, and the flora before us should serve its purpose well. There are a few misprints in addition to those enumerated in the list of errata; perhaps the most obtrusive, if intrinsically one of the least important, is Thompson for Thomson on p. 277.

A A

BRITISH WARBLERS.

The British Warblers: a History, with Problems of their Lives. By H. Eliot Howard. Illustrated by H. Grönvold. Two volumes. (London: R. H. Porter, 1907–1914.) Price 10*l.* 10*s.* net, 2 vols.

"IT is almost impossible to study systematically any species, no matter how common, without continually adding to our store of knowledge and noticing new facts; and such facts may lead to the solution of problems connected with the mystery of life and the greater mystery of development." This sentence of Mr. Howard's may seem trite enough; but it comes not amiss to British ornithologists, whose energies have been mainly occupied with the classification and distribution of species and with the discovery of new subspecies or local varieties rather than with biological questions. Mr. Howard's work, which has been coming out in parts since 1907, has certain decided advantages in comparison with its predecessors, though it deals only with a few species, and biologically only with about a dozen. First, it is the result of most persevering watching, mainly at that time of the day when birds are more full of life than at any other—the hours immediately following sunrise—and at the time of year when, from a biological point of view, they are best worth watching, *i.e.* the months from their arrival in this country to the end of the breeding season. It is true that we have to depend as yet largely on Mr. Howard's evidence alone. But that evidence is, to my ornithological feeling, not only to be trusted with confidence, but extremely stimulating; and as soon as the war is over we shall have numbers of good observers ready to spend their early hours in the woods as vigilantly as in the trenches.

Again, Mr. Howard has not been content with the collection of facts, but endeavours honestly and independently to interpret them, raising and discussing certain biological questions which they suggest. In fact, the work is a valuable study in biology. Imperfect it assuredly is, for the birds treated of from close personal experience are few, and Mr. Howard's experience has been growing during the seven years of publication; but these imperfections are of small moment compared with the stimulus given to inquiry, which has already begun to work among our field ornithologists. If the main results attained could be published in a small and comparatively cheap volume, well thought out, and perhaps more concisely and lucidly expressed than are the more scientific parts of these two big volumes, the benefits of the work would reach a much larger circle than is possible at present.

There is yet another advantage possessed by this book, viz., that it is illustrated by drawings of the most exquisite beauty and delicacy instead of by photographs. The most valuable of these, *i.e.* those which help us to "visualise" the author's observations, seem to be based on his own rough sketches made during observation, worked up to an artistic product with consummate skill and good faith by Mr. Grönvold. Mr. Howard is warmly to be congratulated on having the courage and the means to abandon the cumbrous camera for the mental impression and the pencil. When you are watching little creatures that creep about in dense cover, photography is really impracticable; and if you want to reproduce the attitude of such small birds for a third person you can do it much better if you are an artist than if you are a photographer, if only you have that tender feeling for the living bird which gives you intense delight in all its movements.

Mr. Howard's name will always be associated with what he calls the law of territory—a law which Mr. J. M. Dewar has recently been successfully applying in the *Zoologist* to the oyster-catchers of the Firth of Forth. We are all familiar with exemplifications of this law, and the only reason why it has not been promulgated before is that we have not been up early enough in the morning to realise its working fully. We know well enough that with the exception of the swallow tribe, which find their food in the air entirely, each pair of our summer migrants (and many, too, of our resident species) occupies a certain territory which serves as feeding-ground and playground. If a railway bank is patronised by whinchats, there will be a pair every hundred yards or so; along a roadside it is the same with yellowhammers; in a wood, in reeds, in osiers, with various species of warblers. In such positions as these three last the territories may differ from year to year according to the condition of the cover, but the rule holds good all the same.

Now Mr. Howard has gone far beyond this elementary statement of the law. His vigils have led him to the conviction that this territory is of immense importance in the life of our warblers; that the desire to secure it is what hurries on the males in front of the females during migration; that the vigorous singing on arrival is an announcement of occupation, and a defiance to other candidates for it; and that the bird's sense of boundary is unmistakable, though it may not exactly coincide with that which the observer imagines it to be. (See remarks on this point on p. 10 of the section on the willow warbler.)

There may well be some doubt as to whether

the male birds, in hurrying on, are in any way conscious of this particular end to be attained. Mr. Howard knows well that the sexual organs of these males are beginning to be enlarged before migration, *i.e.* the sexual impulse lies behind the whole operation. If the females of these species are weaker in vitality at the time of migration, this might be enough (as Darwin, I think, thought) to account for the earlier arrival of the males. More convincing is Mr. Howard's oft-repeated assertion that he has seen nothing in these territories to support the theory of sexual selection. What seems to happen is this: a male arrives and takes possession of a territory, and sings vigorously, awaiting a female. If another male intrudes, either before or after the appearance of the female, fights ensue and the intruder is driven out, but there is no indication that the female ever chooses between two males. The song and the strange antics (of which the book contains many beautiful drawings) are the result of sexual emotion, but are not the result of rivalry with another individual. The object is rather to overcome the coyness of the female—which reminds me of Mr. Crawley's theory of a similar phenomenon among primitive human beings, only to be overcome by a ceremony, *i.e.* marriage. This view of the bird's emotional antics leads Mr. Howard to another theory, viz., that the instinct known as "shamming wounded" is only an emotional display of the same kind. In this he was in part anticipated by Mr. W. H. Hudson, who, in his "Birds in a Village" (p. 64, *cp.* "Naturalist in La Plata," chap. xv.), explained the nearly related death-feigning instinct by actual paralysis of the nervous system. More careful observation, combined with physiological knowledge, is needed here. Yet another interesting problem is discussed in connection with the blackcap and marsh warbler, viz., the imitative faculty in song, where the mystery consists in the fact that birds of the year seem to be able to make these imitations without having ever heard the songs which they mimic.

I have perhaps said enough to give some idea of the importance of this contribution to our knowledge of the life of these warblers, and of the urgent need of the embodiment of some of its main conclusions in a cheaper form. I will conclude this notice by congratulating the author on having written the first complete account of the marsh warbler and its life during the breeding season. It is, perhaps, a pity that he should have cumbered this account by a preliminary twenty pages of somewhat obscure biological discussion, which might have formed an appendix or a chapter by itself; but when he is telling what he has himself seen of this charming species, nothing could be better. Only on one or two small points does my experience differ from his. He believes that this bird originally built in reeds like the reed warbler, on no other ground that I can discover but that the nest is sometimes hung in its supporting plants after the fashion of that closely allied species. I do not for a moment doubt his statement, but during my long experience of marsh warbler nests, both in England and abroad, I have never seen one that I could not recognise as such at once. One other point I would contest with him. I believe it to be quite impossible that this species should have been freely distributed in England and yet undiscovered up to the middle of the last century; surely the extraordinary brilliancy of the song is sufficient proof of this. The nest, too, is by no means hard to find, yet among old collections the only undoubted marsh warbler's egg I have ever seen is one found in Somerset some sixty-five years ago, which is now in the possession of the Rev. O. Pickard-Cambridge, of Bloxworth. I am strongly of opinion that the bird has long been, and still is, *slowly* increasing its range.

W WARDE FOWLER.

EDINBURGH MATHEMATICAL TRACTS.

(1) *A Course in Descriptive Geometry and Photogrammetry for the Mathematical Laboratory.* By E. L. Ince. Pp. viii+79. (London: G. Bell and Sons, Ltd., 1915.) Price 2*s*. 6*d*. net.

(2) *A Course in Interpolation and Numerical Integration for the Mathematical Laboratory.* By D. Gibb. Pp. viii+90. (London: G. Bell and Sons, Ltd., 1915.) Price 3*s*. 6*d*. net.

(3) *Relativity.* By Prof. A. Conway. Pp. 43. (London: G. Bell and Sons, Ltd., 1915.) Price 2*s*. net.

(4) *A Course in Fourier's Analysis and Periodogram Analysis for the Mathematical Laboratory.* By Dr. G. A. Carse and G. Shearer. Pp. viii+66. (London: G. Bell and Sons, Ltd., 1915.) Price 3*s*. 6*d*. net.

(5) *A Course in the Solution of Spherical Triangles for the Mathematical Laboratory.* By H. Bell. Pp. viii+66. (London: G. Bell and Sons, Ltd., 1915.) Price 2*s*. 6*d*. net.

(6) *An Introduction to the theory of Automorphic Functions.* By L. R. Ford. Pp. viii+96. (London: G. Bell and Sons, Ltd., 1915.) Price 3*s*. 6*d*. net.

THE publication of this series may be taken to show that the experiment of issuing tracts on advanced mathematical subjects has been a success. The field is so wide that there is no serious risk of overlapping, especially if the

different publishers will announce their programme as soon as they can. Sir George Greenhill, as a veteran tractarian, ought to be personally interested in these successors of his tract on the calculus.

The present series, so far, deals mainly with practical affairs—fortunately not without regard to theory; four of the six tracts are said to be "for the mathematical laboratory." It is to be hoped that this term will not be hackneyed: it is not very happy, in any case, for "a mathematical laboratory" ought to include any place where mathematical experiments are carried on, and experiments are more important than methods of computation. "Number-room" would be shorter and more descriptive; but let that pass, and let us go on to summarise the contents of this parcel.

(1) This has the merit of appreciating the work of Monge, in many ways the greatest master of orthogonal descriptive geometry. The introduction is interesting, though rather amorphous; for instance, the article on "laboratory methods" would have found a better place at the beginning of chapter ii. This chapter deals with a good number of the really fundamental problems on lines and planes; chap. iii. on curved surfaces and space-curves is of a more familiar and less valuable type; chap. iv. is on perspective, and, though very brief, gives some useful hints; chapter v. is on photogrammetry, and the most novel of all. The weakest point in the tract is that nothing is said about dealing with lines that do not meet on the paper; theoretically this is unimportant, but in a drawing-office it is another matter, and auxiliary vanishing points have to be used frequently.

(2) So far as we can judge, this seems to be very well done. There is an outline of the theory of finite differences, the classical formulæ of Simpson, Lagrange, Gauss, etc., and a number of worked and unworked examples. In another edition it might be worth while to give the constants required for Gauss's method (p. 88) in the form of decimals as well as in that of surds.

(3) It is difficult to say what will be the ultimate physical way of stating the principle of relativity, but, thanks chiefly to Minkowski, the mathematical theory is assuming a simple invariant form. The four chapters of this tract deal respectively with Einstein's formulæ, transformation of electromagnetic equations, applications to electron theory, and Minkowski's transformation. Criticism of a physical nature must be left to others; the purely mathematical treatment seems to be all that can be desired. Unfortunately there are very few references—not even one to Minkowski's papers. Without references, a tract cannot perform its proper service as an introduction to an important subject.

(4) This is perhaps the most interesting of the "laboratory" tetrad. The subject being limited, the author is able to give a detailed account, with good examples, of the way in which an irregular periodic graph can be reduced to its harmonic constituents. For work on electric oscillations this tract ought to be very useful. There is also a chapter on spherical harmonics.

(5) This will appeal to astronomers and ordnance survey people, and sailors. The main novelty is the last chapter, on graphical methods, which gives an account of the ingenious inventions of D'Ocagne, Chauvenet, and others. There are numerous examples, worked out to seven places; and others unsolved for the practice of the reader.

(6) This is an excellent tract on what is now an extensive subject. The main points are very clearly put; room has even been found for an outline of non-Euclidean geometry, and the expression of co-ordinates of points on an algebraic curve as one-valued functions. There is a bibliography which seems to include most of the books and papers of really first-rate importance; and there is a sufficient number of diagrams. English-speaking students ought now, at any rate, to appreciate Poincaré's wonderful discoveries in this field.

Mathematicians owe a special debt to Prof. Whittaker for the work he is doing in connection with this series; his encouragement and help are acknowledged in handsome terms by several of the authors. G. B. M.

OUR BOOKSHELF.

Evolution. By J. A. S. Watson. Pp. vii + 153. (London: T. C. and E. C. Jack, 1915.) Price 5*s.* net.

THE object of this work is apparently to provide, in small compass and with copious illustrations, an account of evolution from the lowest forms of life to man. "The Evidence for Evolution" forms the subject-matter of the first chapter, in which well-chosen lines of argument are briefly laid down and illustrated. The three succeeding chapters treat respectively of "Unicellular and Multicellular Animals," "The Worms and some of their Posterity," and "The Early Vertebrates and the Fishes." The fifth, "The Conquest of the Land," leads on to the sixth and concluding chapter, "The Mammals and Man." The illustrations, 146 in number, are largely borrowed from German sources, although the author is wrong in attributing the bust of *Homo primigenius* (Fig. 145) to a German sculptor. It was modelled by an American lady, daughter of Alphæus Hyatt, who will be affectionately remembered by many British

naturalists. It is unfortunate that the abundant illustration should have been permitted to justify the heavy, thickly loaded paper used throughout the book. Apart from this distressing feature, the printing is good and clear, and there are not many errors, among which, however, "Neandertal," "Axolotyl," and "trachea" for the plural (p. 71) were noticed. The figures are sometimes good and mostly adequate, a small proportion being distinctly bad. In some of them the description fails to account for the whole of the reference letters.

In speaking of the analogical groups of the Australian Marsupials (on p. 130), the wombat as a representative of the Rodents is an obvious omission (probably the author intended wombat when he wrote bandicoot); and in asserting that there are no marsupial bats, the flying phalangers should have been mentioned as analogous to the flying squirrels. The statement that the size of insects is "somewhat strictly limited" (p. 71) might have been modified by a reference to Carboniferous times, when these forms had the air to themselves.

We believe, in spite of the faults to which attention has been directed, that the book will be useful because of the wide ground covered, the good selection of examples, and the brevity and clearness of the text. E. B. P.

The Gases of the Atmosphere: The History of their Discovery. By Sir William Ramsay. Fourth Edition. Pp. xiii + 306. (London: Macmillan and Co., Ltd., 1915.) Price 6*s*. net.

JUST complaint has been made recently in NATURE of the dearth of good modern popular or semi-popular literature calculated to inform the public of the methods and achievements of natural science. Nothing could be better for this purpose than Sir William Ramsay's book on "The Gases of the Atmosphere," for here we have a first-hand account of modern discoveries in a connected and highly interesting narrative, and presented in a sufficiently elementary style to make the subject intelligible to a large reading public.

Since the book appeared in 1896 a second and third edition have been issued, keeping the story abreast of discovery. In this, the fourth, edition there is not much new matter beyond an account of the remarkable work done by the author and Dr. Whytlaw-Gray on *niton*. The passage of the story from a record of the intrepid and masterly discovery and isolation of the companions of argon into the realm of radioactivity and modern alchemy is perhaps natural and excusable to the author; but it has the effect of a change of key, and causes a fine record of fact to conclude on a note of speculation.

It is impossible in reading this history of the gases of the atmosphere, in which very even justice seems to be done to all discoverers, not to be struck by the honourable part which has been borne by British men of science. Boyle, Mayow, Black, Priestley, Cavendish, Ramsay, and Rayleigh; to these add Scheele and Lavoisier, and no name remains to attach to any capital discovery about the chemistry of the atmosphere. Without in the least wishing to fall into the evil habit of belittling German chemistry, one may be excused for remarking upon its inconspicuousness in this particular field of work. A. S.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Colourless Crystals of Hæmoglobin.

MAY I have some of your valuable space in order to put a question to physiologists and physicists whom I could not reach so conveniently in any other way?

For a long time I have been puzzled by the existence of colourless—white—crystals of hæmoglobin. If one carries out the familiar experiment of mixing a drop of rat's blood and water on the microscopic stage, one finds that while the majority of the crystals grow out as reddish needles, a few crystals appear to be without colour from the first. But more striking still: I have in my possession a preparation of guinea-pig's blood in which, amongst the beautifully formed, deep red, regular tetrahedra (in which form that animal's hæmoglobin crystallises), there are a few crystals quite as well formed as the rest which are perfectly white. The preparation is two years old; originally all the crystals were red; only a few have become bleached during the last year or so. It may be suggested that the preparation has been unduly exposed to the light; this is not so; except when occasionally examined it has been in the dark.

But what *is* colourless hæmoglobin? Physiologists do not know it, or at least they have not described it. Colourless hæmoglobin in the above sense is not mentioned in the exhaustive monograph of Reichert and Brown. So far as I can learn, no leuco or colourless state of hæmoglobin is recognised analogous to the leuco state (reduced state) of hæmocyanin, a blue respiratory pigment, or to the leucoplastid condition of chromoplastids in plants.

Can these crystals of guinea-pig's blood be regarded any longer as hæmoglobin seeing that all trace of colour or pigment has vanished from them? Is there such a thing as colourless hæmoglobin; are these things not contradictory terms? There is no question here of the removal of hæmatin or of iron from the crystals. The crystals have not been in contact with living tissues or with any active chemical substances at all. Hæmoglobin in old blood-clots, etc., in the living tissues is converted by the removal of iron into hæmatoidin, which, though not always crystalline, is always coloured. Reduced hæmoglobin we know, but it is still a coloured substance (purple), still a pigment; it has a spectrum. If these white, crystalline forms are not hæmoglobin, what are they? And if they are still hæmoglobin, the essence of which is to be a pigment with a spectrum, how can hæmoglobin be colourless? The bush that burned and was not consumed is simple compared with the problem here.

D. FRASER HARRIS.

Dalhousie University, Halifax, N.S., January 12.

Asteroids Feeding upon Living Sea-Anemones.

THE following instances of asteroids feeding upon living sea-anemones may be of general interest.

On October 27 three healthy examples of the sun-

star (*Solaster papposus*), of 8 to 9 cm. across their extended arms, were placed in an aquarium at the Horniman Museum at Forest Hill. The aquarium already contained a whelk shell on which was an average-sized "parasitic" sea-anemone (*Sagartia parasitica*). It should here be remarked that the sun-stars were well fed daily (on pieces of fish, beef, mussel, or starfish), and they could not therefore have been driven by hunger to eat unaccustomed food. At 9.30 a.m. on December 31 it was discovered that one of the sun-stars was on the pebbles, humped in the characteristic feeding posture over the sea-anemone, which had apparently been dragged from the shell. Some of the arms of the sun-star were raised and attached by their tube-feet to the glass of the aquarium, and the stomach of the asteroid could clearly be seen enveloping about one-half of the coelenterate. Numerous white acontia were attached to the under-parts of the sun-star. At 10.30 a.m. on the following day the sun-star was still upon the sea-anemone. The sea-anemone was now removed from the aquarium, and it was found on examination that the dead coelenterate was closed, and that the integument of its upper parts, together with most of the tentacles, had disappeared, having apparently been digested away.

On January 13 another "parasitic" sea-anemone, the diameter of whose circle of extended tentacles was about 4 cm., was placed in the aquarium, and at 9.30 a.m. on January 15 it was found that it also had been dragged from its shell and was enveloped by a sun-star, which may or may not have been the same individual. On this occasion the sun-star was not disturbed in its meal. On January 17 it was still upon the sea-anemone, but it had dragged its prey up a vertical rock. When the sun-star was gently lifted, it was found that the sea-anemone was inside the partially everted stomach, only the central part of the base of the coelenterate being exposed. On the morning of January 18 (that is, at least seventy-two hours after the attack) the sun-star was still humped a little, and on its being turned over it was found that there were no signs of the sea-anemone, except a small dark-brown slimy mass, which the sun-star hastily discharged from its mouth.

The apparent indifference of the sun-star, with its everted, and one would think vulnerable, stomach, to the acontia is to be remarked. It would be of interest to know whether any reader of NATURE who may be working at the asteroids has witnessed or heard of an incident similar to those described above. I may add that another average-sized "parasitic" sea-anemone has been in the tank since the introduction of the sun-stars, but it has not yet been eaten, although a sun-star will occasionally place itself over the coelenterate and then creep away again.

H. N. MILLIGAN.

Devonshire Road, Forest Hill, London, S.E., January 29.

William Smith's Maps.

I AM preparing a monograph on Smith's maps, etc., for the Yorkshire Geological Society, and am anxious to see a "Reduction of Smith's large Geological Map of England and Wales intended as an elementary map for those commencing the study of Geology, 1819," referred to in Phillips's "Memoirs of Smith."

I find that Smith's large maps of 1815 often bear a signature and a number such as "No. 66," or "a 33." If any readers of NATURE possess copies of this large map perhaps they would kindly inform me what number the map bears. It occurs under the "Section of Strata," which appears on the map to the east of the Humber estuary.

T. SHEPPARD.

The Museums, Hull, January 25.

OPTICAL SIGHTS FOR RIFLES.

OF all instruments needing accurate pointing, the rifle has been longest deprived of the aid of optical appliances. Probably this is due to a variety of reasons, among them being: (1) the rough usage to which a rifle may be subjected; (2) its use in warfare is essentially youth's prerogative, with ample visual accommodation, so that the disadvantage of open sights is not acutely felt; (3) the little incentive received from the use of the shot gun with its spreading discharge, and short range not demanding optical aid, as practice and judgment enter largely into the act of aiming in much the same way as they do in throwing a stone. Nevertheless, it is apparent that the rifle is progressing through various phases as other pointing instruments have done.

The drawbacks of open sights are obvious —a near back-sight, a foresight, and a distant object all require to be focused at the same time, or rapid visual accommodation made (see NATURE, June 24, p. 462).

Optical sights for rifles may be divided into three classes: (1) The use of lenses without any tube, as in the early aerial telescopes, the

FIG. 1.—Common's optical sight, showing lens at muzzle end, as made by Ottway and Co., Ealing.

rifle itself being used as a base on which the lenses or lens and sighting hole are independently mounted. (2) Use of lenses to give a reference line, with or without other optical aid; these are termed collimating sights. (3) Telescopes, prismatic or otherwise, complete in themselves with optical or mechanical appliances for elevation or deflection, and means for ready attachment to the rifle.

One of the earliest of class 1 is to be found in a patent by Chase in 1893, in which the foresight consisted of a lens mounted near the muzzle of the rifle, the focal length of the lens being such that objects sighted at a distance had their images in the same plane as the rear sight. This image could be viewed either by the naked eye or by optical means, and, of course, it appeared inverted. Such an instrument has obvious disadvantages, but is capable of bringing all the demands on the eye to a vision of one plane.

Another single lens sight which is entirely practical, and has achieved considerable success, was patented by the late Dr. Common in 1901 and called by him "the optical rifle sight." It consists of a lens mounted near the muzzle of

the rifle, and a pin-hole or orthoptic mounted near the breech; the focal length of the lens is greater than the distance between it and the pin-hole. Figs. 1 and 2 show one of the arrangements employed. The whole sight weighed about three ounces, and there was the minimum of apparatus to get out of order. The line of aim is provided by the line joining the pin-hole and a small dot ground on the lens at the optical centre, the lens being edged so that the spot is also the geo-

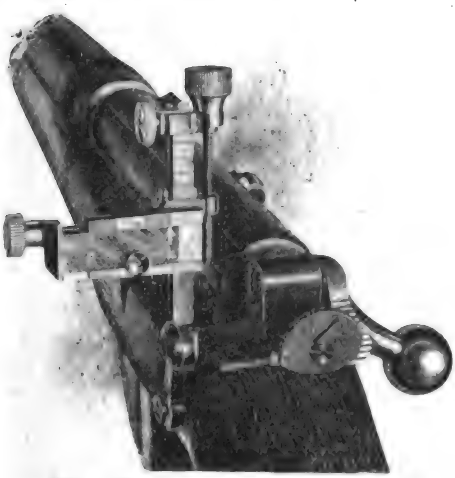

FIG. 2.—Pin-hole or orthoptic near breach end.

metrical centre in order to provide against rotation of the lens in its mount; the orthoptic can be elevated or deflected as shown, and thus any line of aim suitable for a rifle can be attained. The sight gives a magnification of about three times.

In introducing this sight Dr. Common offered a prize in the Bisley meetings of 1902 and 1903, the service rifle to be used, the range being 1000 yards, and the optical sight to be so mounted that it did not interfere with the ordinary open sights of the rifle. Some good shooting resulted,

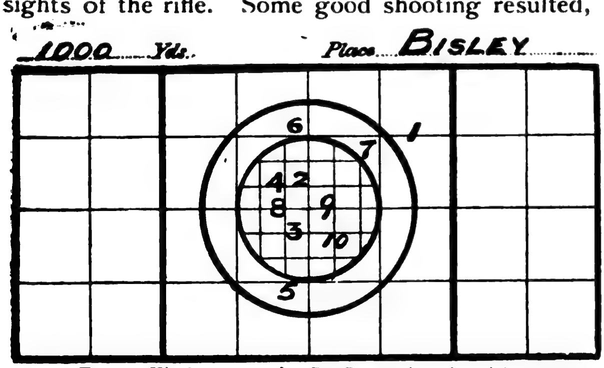

FIG. 3.—Hits by a tyro using Dr. Common's optical sight.

and as a proof of the efficiency of the sight Fig. 3 represents the hits by the writer, who had never previously shot at the butts. This sight received some theoretical criticism as regards its use by "myopes," but by practical trials with lenses of suitable focal length, two riflemen with eye corrections of -2 diopters were able to improve their shooting considerably. To make the sight suitable for different visions, the Birmingham Small Arms Co. made an improvement by adding a negative lens to the orthoptic, thus converting the sight into a Galilean telescope; this improves the definition of the target, and since vision is made through the concave lens and a peep-hole,

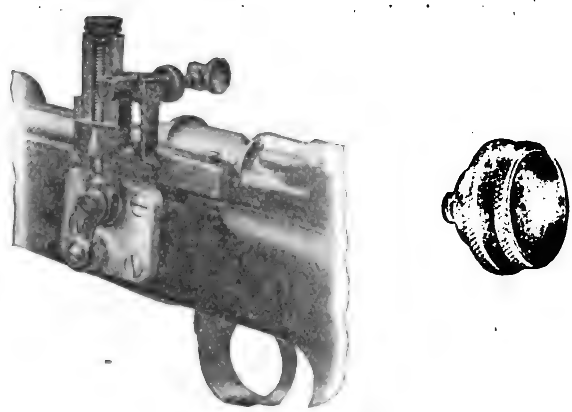

FIG. 4.—Orthoptic and negative lens back sight for use with optical fore sight, as made by the B.S.A. Co.

the definition of the mark on the lens is not seriously impaired.

Coming to collimating sights, the earliest, that by Sir Howard Grubb, was described in NATURE of January 9, 1902. The following is a quotation from that article:—

By means of the sight a virtual image of a small bright cross or circle is projected on the object aimed at. The earliest form in which the sight was made

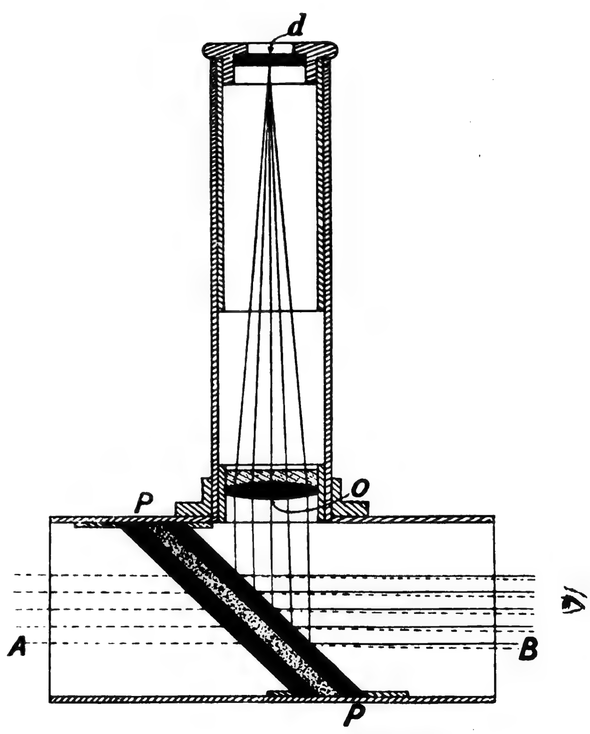

FIG. 5.—Sir Howard Grubb's collimating sight.

is shown in Fig. 5, in which the object aimed at is viewed through a tube open at each end, a piece of parallel glass, PP, being fixed at an angle of 45° to the axis of the tube. In another tube at right angles to the former a diaphragm *d* is fixed, made of an opaque

substance through which fine lines are scratched in the pattern of a cross or star or circle. O is an achromatic lens, and the distance between the cross and the lens equals the principal focal length of the lens; so that rays of light passing through the cross, on reaching the lens, are by it made parallel; they

FIG. 6.—Grubb's sight aligned on a distant object.

are then reflected by the plates PP as parallel rays to the observer's eye, and the observer sees a "virtual" image of the cross coinciding with the object aimed at, and apparently at the same distance as the object. This optical device causes the cross to be seen sharply defined, with the same focusing of the eye required for viewing the distant object, and all straining of the eye, as is the case in the old system, vanishes; also there is no parallax, and therefore the eye need not be kept in one position. This "virtual" image of the cross forms a foresight projected to a long distance in front of the rifle, as if it were carried upon an invisible, imponderable, and inflexible prolongation of the barrel.

The optical arrangement of the sight was afterwards modified to make it convenient for mounting on a graduated arc attached to the rifle, but its principle remained the same. Grubb's sight may be used with or without a telescope, since the same focus suits both the object and the image of the cross; also by cutting divided scales on the diaphragm glass, useful estimates may be made of both distance and windage.

Fig. 6 shows a photograph taken by a camera placed behind the sight and focused on a distant object; both the fiducial cross of the sight and the distant object are seen to be in perfect focus.

Several other collimating sights followed, the simplest, apparently originating in France, though patented by Krupp in England, is one in which a long Stanhope lens is used, the lens having a V-shaped channel cut along its entire length, and the apex of the channel being the axis of the lens. A sight may thus be taken along the groove, whilst at the same time a portion of the pupil of the eye catches parallel rays issuing from the lens, on the flat remote face of which is a fiducial mark.

Mr. Dennis Taylor, of the firm of Messrs. Cooke and Sons, York, took out a patent in 1901, in which use was made of a Galilean telescope to which was attached a collimator; the upper half of the eye-lens of the telescope was cut away and a prism substituted in its place. The function of the prism was to direct the emergent beam from the collimator into juxtaposition with the emergent beam from the telescope, so that both beams were visible at the same time. Dr. Common and others used this half-eye or half-pupil arrangement for viewing two objects at the same time, but none met with success, chiefly because the average person experiences great difficulty in adjusting the eye with that nicety required to catch the two beams at the same time.

To obviate the difficulties arising from the half-pupil arrangement, Common employed the principle of the collimating sight in other ways; in a patent of 1901, he used a small collimator with its mark at the principal focus of the lens, hence, looking into the sight, the mark appeared at infinity. If, now, both eyes remained open, one might be used to look at the object aimed at, whilst the other eye looked into the collimator; the fiducial mark could then be superposed on the target. This sight would answer perfectly well if fusion of the different visual fields could be obtained, but when the eyes are used in this way, "antagonism of the visual field" occurs[1] and the whole or part of one of the fields may be suppressed and the sight becomes useless.

FIG. 7.—Dr. Common shooting with telescope rifle sight in "Winans" competition, Bisley, 1902.

[1] Tscherning, "Physiological Optics," p. 323.

In a patent of 1902 Dr. Common used the combination of a collimator and a Galilean telescope, much in the same way as that of Mr. Dennis Taylor described above, but with this difference: the collimator mark was placed beyond the principal focus of the lens and thus the rays emerged convergent, the convergency being the same as the rays within the telescope proceeding from the objective. The rays were then deflected by an inclined mirror and were brought to a focus on the same image plane as that of the telescope's objective, and could thus be viewed by the same eye-piece.

Many of the above sights have the inherent defect of the Galilean telescope, *i.e.*, a very small field, and were merely side issues to the purely telescope sight, with its large field and compact form. One of the earliest telescope sights is to be seen at Bisley, and was used in the U.S.A. Civil War. From then onwards many attempts were made to combine successfully the rifle and telescope to withstand active service. By 1901 Common had perfected his telescope rifle sight, and he was shooting at Bisley in the "Winans" competition of that year with a telescope sight, which to this day has not been improved as regards the principles employed. The body of the telescope was of steel, light and strong, a minimum of parts was used, and every fundamental part was rigidly fixed so that the shock of firing could not disturb the optical axis. The lenses of the eye-piece were so arranged that the Ramsden circle was nearly two inches behind the telescope, so that the jerk of recoil could not easily cause injury to the eye, and the emergent pencil was large and easily picked up. Inside the telescope a parallel plate of glass, turning about a vertical axis, was provided to give a lateral deflection to correct for windage. The whole was mounted on a base, inclinable by means of a specially shaped cam to provide for elevation when long ranges were required; whilst for shorter distances the telescope was fixed and allowance for change of range was made by moving the sighting pointer by means of a screw. The whole was then so arranged that it could be instantaneously attached firmly to the rifle near the breech without interfering with the ordinary open sights.

Some German firms embodied all Common's ideas in the manufacture of telescope sights, even to the use of eccentric rings in which the object glass was mounted for the adjustment of the axis of collimation, but Zeiss made use of a "Leman" prism, a variety of the "Porro" prism system which the firm had used in the manufacture of binoculars. The Zeiss prism telescope sight is really a small periscope, the prism system enabling the eye to be placed on a lower level than the object glass. It is a small instrument, but in consequence of the number of reflections and thickness of the prism, more light is lost in transmission than in the simple telescope; further, its shape is not conducive to easy alignment. In order to obtain elevation for different ranges, the object glass is mounted in a sliding fitting which is actuated by a milled edge ring. On turning the ring a vertical motion is given to the object glass and a corresponding shift to the optical axis; the ring is graduated to suit the equivalent change in range.

In the Zeiss and the similar Goerz prism rifle sight, means are provided for illuminating the cross wires at night. A small beam of light is transmitted through the edge of the glass diaphragm on which the lines are engraved; most of the light passes through the diaphragm, since

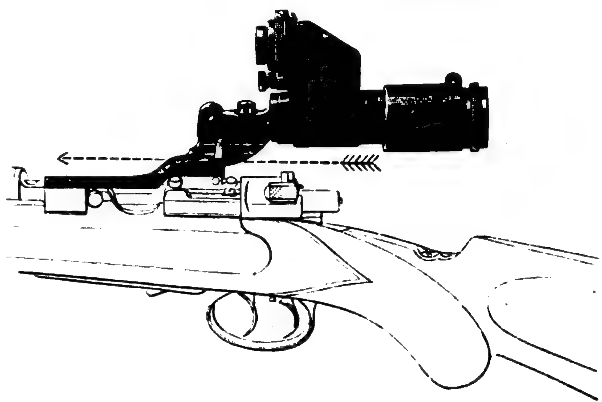

FIG. 8.—Zeiss prism telescope sight.

total internal reflection is secured, except where the rays strike the incisions in the glass, thus illuminating them, whence they appear as bright lines on a dark field.

Later, for long-range shooting and machine-guns, this sight has been mounted, by the Aktiengesellschaft Hahn für Optik, on an elevating arc to obtain the various ranges, and the objective made adjustable in a plane at right

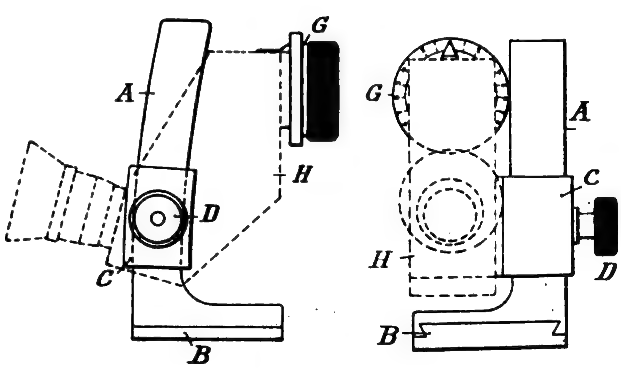

FIG. 9.—Prism telescope sight on elevating arc with lateral correction to object glass for windage.

angles to the line of vision to obtain the lateral displacement for wind and other causes.

Accurate shooting in modern warfare is essential, whether of rifle or machine-gun; a hit is more valuable than any number of misses. The telescope sight is an aid to this end, but it is handicapped by the fact that rifles are not made with breech ends suitable for its easy attachment, but probably its severest handicap is the lack of official encouragement of the optical industry in this country.

W. S.

PREHISTORIC ART.[1]

In an advancing science like anthropology, it is well to take stock periodically of the material which is so rapidly being accumulated. Mr. Parkyn in this book displays much industry in studying the literature of the subject; but his work must not be taken to be the last word on the subject, nor does it supply an adequate history of prehistoric art. His survey covers an enormous period, from the Palæolithic Age down to that of Late Keltic ornament, and the pressure on his space in dealing with such a mass of material necessarily forbids detailed investigation of evolution or æsthetics, while his imperfect sense of style and the desire to compress the facts make his book hard reading. At the same time, it is well documented and provided with a number of good illustrations, some of them in colour, and many old friends, which will render it useful to the student if he is prepared to treat it as a "source" book. It may be used with advantage as a supplement to the "Ancient Hunters," by Prof. Sollas, who has described with notable success early man from the physical and ethnographical side.

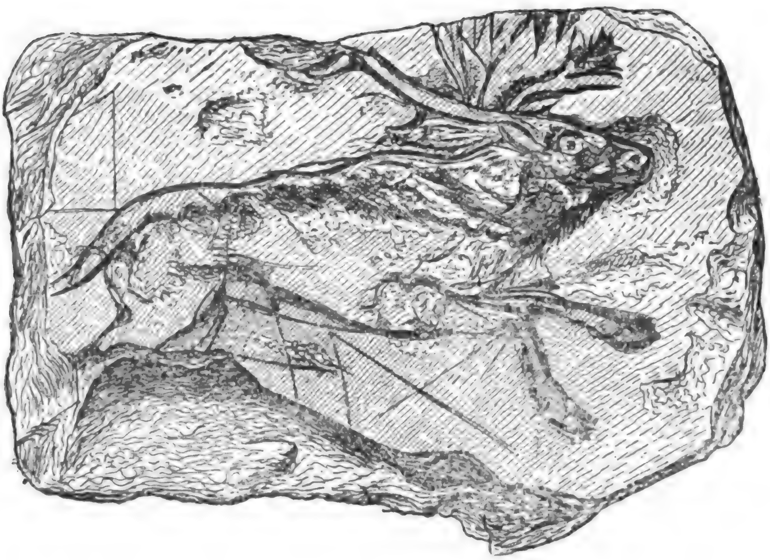

FIG. 1.—S. Marcel. Reindeer on schist. (Natural size.) From "An Introduction to the Study of Prehistoric Art."

The account of the cave frescoes, which constitutes the most valuable part of the book, opens up a school of art our knowledge of which starts from the discovery in 1879, by M. S. de Santuola, of paintings in the now celebrated cave of Altamira à Santilane, near Santander, in north-west Spain. Since then numerous discoveries in the Pyrenean and Dordogne regions and in Spain have largely added to our knowledge. They introduce us to an art school, keen observers of the animal life which surrounded the workers, and possessed of admirable skill both in drawing and painting. Mr. Parkyn, except in a summary way, does not discuss the many points of interest suggested by these frescoes. He believes that the art of sculpture preceded those of engraving and painting, but the materials at present available seem to be insufficient to indicate the seriation or course of evolution of these phases of art production. Another interesting fact is that while the artists represent animal forms with much skill and powers of observation, their delineations of the human form are little better than caricatures, even if it be admitted that some examples represent masked dancers. Again, as at the cave of Combarelles, the paintings occupy the walls, not of the outer dwelling-place, but are found in an interior gallery. These facts have led to the theory that the frescoes adorned the walls of some kind of shrine in which a form of animal or totemistic cult may have been carried on. The human performers are regarded as subordinate to this ritual, whatever form it may have taken, and the object of the cult may have been to promote the fertility of the fauna which supplied their food or to act as a kind of magical performance to ensure success in the chase. But all this is still very uncertain, and we must await fuller knowledge.

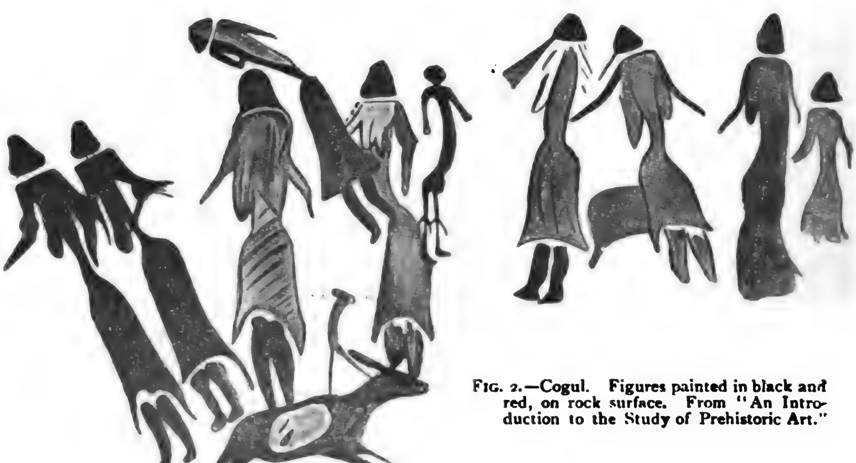

FIG. 2.—Cogul. Figures painted in black and red, on rock surface. From "An Introduction to the Study of Prehistoric Art."

Another interesting point which might have been discussed with more detail is the strange

[1] "An Introduction to the Study of Prehistoric Art." By E. A. Parkyn. Pp. xviii+349. (London: Longmans, Green and Co., 1915.) Price 10s. 6d. net.

break in artistic skill, of which we have at least two instances: the decline in skill in stone-work in the Solutrian period as compared with that of La Madelaine, and the equally remarkable failure in artistic powers of Neolithic as compared with Palæolithic man. In the first case, Mr. Parkyn suggests that the decline was due to the worker finding other fields for his artistic skill in the use of bone and horn instead of stone, and to the growth of the taste for engraving. In the latter case it can only be suggested that it depends on a difference of race and environment, the age of polished stone marking the beginnings of settled life, agriculture, and cattle-raising.

Enough has been said to indicate the value of this book, provided that the reader does not expect from it what it was not intended to supply. The field is still open for a monograph on the art of the Ages of Stone in which the evolution of the crafts of these early workers and the artistic spirit shown in fresco, sculpture, and the working of an intractable material like flint shall receive adequate examination.

THE ORGANISATION OF EMBRYOLOGICAL RESEARCH IN AMERICA.

WHEN British anatomists come to examine "Contributions to Embryology,"[1] which have been issued by the Carnegie Institution of Washington as publications numbers 221, 222, they will be less than human if they do not feel a twinge of jealousy. Five-and-twenty years ago anatomists in America were British in method and in spirit; they were easy-going, each man following leisurely his own individual bent. Since that time a remarkable change has taken place; the number of laboratories in which the structure and development of the human body are taught and investigated have increased tenfold; the number of investigators has grown in a still greater ratio; in quantity and quality their anatomical proceedings and journals have come to rival those of any country in Europe.

In effecting this transformation the chief credit must be assigned to one man—Franklin P. Mall, for twenty-three years professor of anatomy at the Johns Hopkins University. He planted in Baltimore the methods and aims which he acquired when working in the laboratory of the late Prof. His at Leipzig. By his personal influence and example, by pupils and disciples, and by reason of the inherent excellence of the Leipzig traditions, he has succeeded in Germanising the majority of the dissecting rooms and anatomical laboratories throughout the length and breadth of North America.

The issue of "Contributions to Embryology" marks a new phase in the career of Dr. Mall and the beginning of another period in the history of human anatomy in North America. In 1913 Dr. Mall issued "A Plea for an Institute of Human Embryology."[2]

[1] Carnegie Institution of Washington Publications, Nos. 221, 222. "Contributions to Embryology." Vol. i., No. 1. Vol. ii., Nos. 2-6. Vol. iii., Nos 7-9.

[2] *Journal of the American Medical Association*, 1913, vol. lx., p. 1509.

"At present," he wrote, "it seems impossible for the investigator-teachers to make greater progress than is here shown without better organisation, and it is for this reason that I renew the plea of His for an Institute of Human Embryology. Only in this way can we hope to secure a complete *embryologic* and scientific basis for human anatomy which, it is being recognised, is in a chaotic state. . . . There should be an Institute of Human Embryology just as there is one for Human Palæontology recently founded in Paris by the Prince of Monaco."

The conception of founding such an institute in North America is Dr. Mall's, but the possibility of its realisation was Mr. Carnegie's. At the close of last year (December, 1914) the trustees of the Carnegie Institution of Washington established a Department of Embryology, appointed Dr. Mall as Director, and gave him an "investigatory staff," which includes some of the leading embryologists of the present day, with all forms of skilled assistants needed in laboratories of such a kind. At present Dr. Mall and his staff are housed in the cheap brick building which forms the Anatomical Department of Johns Hopkins University. The new institution or department of embryology is already at work, and the manner in which it is to fulfil its destiny may be inferred from the high quality of vols. i. and ii. of "Contributions to Embryology."

In vol. i. Dr. Mall gives the results of minute examination of 117 specimens where the human ovum had been arrested in the Fallopian tube, and started to develop there in place of passing on to its normal site in the uterus. When the late Mr. Lawson Tait, some thirty years ago, showed that the lives of women who were the subjects of tubal pregnancy could be saved by prompt operation, the condition was supposed to be rare; we now know that it is common, and there is an ever-growing body of evidence which demonstrates that it results from an inflammation of the tube, often venereal in nature. The facts observed by Dr. Mall support the theory of an inflammatory causation. In above 90 per cent. of the cases he found that the embryo was also diseased or arrested in development. For anyone who would continue a research on tubal pregnancy—or who may wish to know the best that can be known of the subject at present—a study of Dr. Mall's records and illustrations is absolutely essential.

In the second volume there are five papers, all of them forming definite and useful additions to our knowledge of the human embryo. Dr. James Crawford Watt describes two very young twin embryos, at a stage of development which has not been recorded before. Prof. Eliot Clarke gives an embryological explanation of a very rare anomaly—a subcutaneous vessel taking the place of the thoracic duct. Dr. Charles R. Essick describes certain transitory cavities which occur in the developing ganglia at the base of the brain. The two remaining papers are devoted to the growth of the human fœtus and to the development and nature of the corpus luteum of the ovary.

In vol. iii. the same high standard is main-

tained, both as regards the quality of the text and excellence of the illustrations. Prof. Florence Sabin gives a summary of her researches into the development of the great systemic veins of the abdomen, the result being to modify very considerably our present conception of the nature and origin of the inferior vena cava. She found that the posterior cardinal veins disappear with the Wolffian bodies during fœtal life, and take no part in the formation of either the inferior vena cava or azygos veins. We note that Miss Sabin has attained her ends by reverting to a method which had fallen into disuse—that of injecting the embryonic blood vessels. Dr. J. Duesberg contributes a paper on "Recherches cytologiques sur la fécondation des Ascidiens et leur développment," his conclusions being in support of those experimental embryologists who believe that the bases of the organs of an embryo are localised at certain definite points in the cytoplasm of the developing ovum. The final paper in vol. iii. is by Dr. P. G. Shipley and Dr. G. B. Wislocki, and describes the development and structure of the poison glands of *Bufo agua*. The secretion of these glands contains a substance identical with that secreted by the suprarenal bodies. At the same time, this paper shows the advantage of combining the labours of an expert chemist with those of an expert anatomist.

A. K.

SCIENCE AND COLONIAL AGRICULTURE.

AN article in a recent number of the *Agricultural News* (Barbados) discusses the probable effects of the war upon the organisation of science from the Imperial point of view in relation to industry generally and in particular to Colonial agriculture. This subject has been dealt with so exhaustively on all sides during the last twelve months that it would seem impossible to advance any new ideas about it, but the writer of the article selects two fundamental causes as responsible for the state of affairs prevailing until recently. He believes that the British character includes a keen appreciation of mechanical invention without any appreciation of the scientific research underlying it. The second reason is that science as a profession is considered by the older universities and public schools as lacking in the essentials of refinement, and that this social stigma deters able men of good position from entering it. But this deduction is surely incorrect; the true explanation lies in the fact that the prizes that science can offer are so meagre compared with those held out by other professions. The social question is merely a secondary effect. This aspect of the matter was referred to by Sir William Tilden, speaking as a representative of the Royal and Chemical Societies at a deputation to the Government a short time ago.

While in the case of manufacturing industries individual enterprise in recognising the true value of scientific work, can, and actually has, achieved much, practically nothing can be done in relation to agriculture without organisation. No single farmer can afford to employ an expert to advise him on the scientific cultivation of his land, nor can any single scientific worker, however able, cope with more than a few of the varied problems that practical agriculture constantly presents. For this reason agricultural science is, in most countries, much more highly organised than any other of the applied branches. We do not think there are serious grounds for the fear expressed by the *Agricultural News* that in the general move to help the manufacturer British and Colonial agricultural science may be neglected. The Imperial Government seems to be alive to the importance of encouraging agriculture in all its branches within the Empire, and while some alteration of methods may be necessary, it is unlikely that any permanent reduction of scientific work will occur.

It is interesting to learn that in the West Indies there is the same lack of intelligent contact between the actual producer and the scientific worker that is still too obvious at home. There is also a need of more frequent intercourse between the agricultural experts, which is hindered by the natural difficulties of communication among the islands, and now almost impossible owing to the war. An optimistic view is taken of the future; it is hoped that the brighter outlook for science will attract more men of the best type, and that in the renaissance of science throughout the Empire agriculture will play its part.

THE PROPOSED CLOSING OF MUSEUMS.

AS we write, there are rumours that the Government is reconsidering the question of the closing of museums, at all events as regards the Natural History Museum, but, whatever be the ultimate decision, the whole affair has been a moral victory for museums, especially for those illustrative of science. We might have gone on for years without suspecting this warm appreciation on the part of the public; but the mere threat of a temporary closing has aroused a hurricane of protest, remarkable alike for the variety and vigour of its expression and for the number of interests and classes represented. One of the advantages of a non-party Government seems to be that it elicits the real opinion of the nation, and surely it is long since a Government proposal has been rejected with so near an approach to unanimity. Its supporters in the Press have included Mr. Evelyn Cecil, whose unhappily chosen parallels of football, fox-hunting, and racing only make more clear the essential educational value of museums; and Mr. Harold Cox, who quotes Madame de Maintenon to the effect that we all advocate retrenchment except when it affects ourselves. This is true, but when everybody cries out, it is because the interest attacked has become almost a necessity of life.

The necessity and the value in their diverse aspects have been emphasised in the *Times* and other periodicals by Lords Morley, Bryce, Grenfell, Sudeley, and Sydenham, by Sir Richard

Temple, Sir F. Treves, Sir Thomas Barlow and other distinguished physicians, Sir Edward Fry, and Sir Harry Johnston, by Dr. A. E. Shipley and Dr. Gregory Foster, by Mrs. Creighton and Mrs. J. R. Green, by Messrs. Halsey Ricardo, Walter Sichel, and Frank Brangwyn, as well as by a number of distinguished people more immediately connected with museums of art or science. The dubious economy of the proposal was well brought out in letters by Mr. G. W. Prothero and a "Past President of the Museums Association."

In a few cases the writers attempted to overcome difficulties which really do not exist. The claim that the closing alone will effect a saving of 50,000*l.* cannot be maintained in the light of Lord Morley's figure of only a little more than 2000*l.* for the huge Natural History Museum. The idea that the galleries of this museum could be used for clerical work was, we believe, suggested some time ago, but presumably found impracticable. Many suspect a reason in the greater safety of the collections; but this was attended to long since, and the removal of the more valuable objects from the public galleries of various museums has not impaired their educational activities; indeed, the contrary has been maintained. The idea that a number of active young men are still at work in these establishments is on a par with the myth of the policemen of military age. No body of men rushed more readily to the colours, and we do not believe that one is left to be compelled. If convalescent soldiers were employed to watch the galleries they would only release veterans who are, or soon will be, candidates for Chelsea Hospital; far better let the commissionaires, who perform their duties so admirably, stay where they are, and employ the convalescents elsewhere. One offer, however, might well be accepted: if there are competent people willing to help with demonstrations in the galleries, by all means let them. Even if red tape delays an official welcome, there is nothing to prevent them from organising small parties on their own initiative, and so doing a really useful work. Such aid would at all times be valuable on Sunday afternoons.

The Government may withdraw, but have our rulers learned their lesson? Do they understand that, instead of suppressing museums, they should utilise them? And the museum-people in their turn—possibly if some of them were a little more ready to adapt their exhibitions to the necessities of the time, no Government would dream of dispensing with such potent allies.

SIR CLEMENTS ROBERT MARKHAM, K.C.B., F.R.S.

JUST the accident of setting his bed alight with a candle, and the shock resulting from his effort to subdue the flames, led to the death of Sir Clements Markham on the evening of Sunday last, January 30, at his residence in Eccleston Square, London.

Sir Clements was in his eighty-sixth year, and although intellectually vigorous he had been a sufferer from gout for some years past, and was frequently confined to his room, where his active mind was ever engaged in those literary researches in the field of geography the results of which are so well and so widely known. He was a member of a good old northern family; his great-grandfather (not his grandfather as stated in the *Times*) was Archbishop of York, and at one time Headmaster of Westminster School, a fact which accounts for the deep interest in that school which was maintained by Sir Clements during his lifetime. His grandfather was William Markham, private secretary to Warren Hastings and resident at Benares, who stood in the same relationship to Admiral Sir Albert Hastings Markham as to Sir Clements.

Sir Clements Markham was born at Stillingfleet in Yorkshire, his father (Rev. David Markham) being vicar of that parish and Canon of Windsor. His mother was a Milner. The Markhams were a naval family, and young Clements followed the family profession, entering the Service in 1844 and retiring as a lieutenant in 1852. His early experiences as a sailor coloured his scientific outlook during his whole career. He was a devoted friend to the sailor, and this devotion led to an enthusiastic support of naval (Royal Naval) enterprise in Arctic and Antarctic fields which occasionally pressed rather hard on the requirements of other geographical projects. It was as a sailor, after his experiences with the Franklin Search Expedition in 1850–51, that he commenced his literary career, a career which marked him as perhaps the most prolific geographical writer of the day.

So early as 1852 Sir Clements acquired his first experiences as a land explorer in South America, when he visited Peru on a quest for information about the Inca period, and it was there that he made those investigations which rendered him an expert authority on that country. His greatest work in the cause of humanity was undoubtedly the introduction of cinchona from Peru into India, on which enterprise he was employed by the Secretary of State for India in 1859–60. He was successful both in the collection of plants and in the arrangement of plantations in India. The beneficial results of that enterprise to the fever-stricken plains and jungles of India can only be compared with those which have been attained by the discovery of the germ-carrying mosquito. Quinine was at once placed within financial reach of the mass of the people. Peruvian experiences formed the subject of books and pamphlets which appeared from his pen at intervals for many years. "The Incas of Peru," published in 1910, was the latest.

From 1863 to 1888 Sir Clements was one of the Hon. Secretaries of the Royal Geographical Society. They were busy years when pioneer explorations from every part of the known world into regions of the unknown were leading to sensational revelations and extending our geographical map knowledge with great rapidity. His position as

secretary brought him into direct contact with most of the leading explorers of the day, and his untiring energy and literary ability were of the greatest service to the Society in collating and recording the result of world-wide investigations. He received the gold medal of the Society in 1888, when he became its president, a position which he held for eight years. Meanwhile, in 1868, he joined the expedition which reached Magdala (Abyssinia) under Lord Napier; and it is evidence of his unusual capacity both for personal observation and the collection of material which would in these days be classed under the head of "intelligence," that he wrote the best popular account of that remarkable expedition which has yet appeared. For ten years after this Sir Clements was in charge of the Geographical Department of the India Office, and this appointment gave him the opportunity for rescuing from oblivion the neglected records of the Indian Navy, and of writing a history of the Indian Survey. The latter is the only popular work on this subject which exists, and it much wants a writer of the ability of Sir Clements to bring it up to date.

As president of the Royal Geographical Society Sir Clements Markham has left an abiding name. It is not too much to say that he gave his whole soul to the work of maintaining the usefulness of the Society in every branch of geographical activity. He succeeded in impressing the administrative authorities of Government, as well as those of the leading universities, with the necessity for widespread geographical education. Geographical schools and teachers began to be busy, and much of the present interest which is maintained in maps (to be found in every newspaper now) is due to his initiative. If Sir Clements appeared to be somewhat autocratic in council it is at least due to him to say that it was his personal determination which carried through many a project which would have failed in weaker hands. Notably he must be credited with the success of the first Antarctic expedition under his own nominee, Captain Scott. That expedition gave an impetus to Antarctic discovery which has not ceased yet. As president at the meetings of the Society he was a clear and vigorous speaker, and he always succeeded in importing something of his own vitality into every subject which he handled. A firm, strong friend was Sir Clements, and a somewhat pugnacious enemy; a man of strong views, and possessed of that rare courage—the courage of his opinions. As president of the Hakluyt Society he rescued many an old record from oblivion, and has given to the world a series of most interesting books of ancient adventure and travel—works which will survive through the ages. T. H. HOLDICH.

NOTES.

THE issue of *Science* for December 24 last prints an address by Dr. L. H. Baekeland delivered before a recent joint meeting of the New York Section of the American Chemical Society, the American Electrochemical Society, and the Society of Chemical Industry, on the recent proposals of the Naval Consulting Board of the United States. Dr. Baekeland is a member of the board, and this address is the first public report of the discussions of the board on the so-called "five-million laboratory" proposed by the Naval Consulting Board. The contemplated outlay for the navy for the next five years, for new ships, aviation, and reserve of munitions, amounts to 100,000,000*l.*, and the argument of the address is that an expenditure of this magnitude ought to be made as efficient as possible. All doubtful and inferior devices must be eliminated by direct experiment, by research and tests, before it is too late to remedy them. The advisory board has stated the facts as it saw them, and confronted the secretary of the navy with the probable maximum expenses for research and experimentation, commensurate to the five years' naval building programme now under contemplation. The five-million dollar budget, or 1,000,000*l.*, for experimental work to be expended during those five years, or about 200,000*l.* a year, may, says Dr. Baekeland, strike the uninitiated as needlessly large, although it is only about what some industrial enterprises have found necessary to spend on their own experimental work. The corrosion of condenser tubes of American warships involves an annual damage of about 400,000*l.* If 200,000*l.* were spent on research on this problem alone, with the result of reducing the damage to one-half, the total outlay would be compensated in a few months' time, aside from the important fact that the fleet would be stronger because less of the ships would be unavailable for service.

DR. C. GORDON HEWITT, dominion entomologist of Canada, has been elected president of the American Association of Economic Entomologists for 1916.

AT the annual meeting of the Challenger Society on January 26 the following officers were elected for the ensuing year:—*Secretary*, Mr. C. Tate Regan; *Treasurer*, Mr. E. T. Browne; *Committee*, Dr. S. F. Harmer, Mr. D. G. Lillie, and Prof. E. W. McBride.

THE gold medal of the Royal Astronomical Society has been awarded to Dr. J. L. E. Dreyer, for his contributions to astronomical history and his catalogues of nebulæ; and it will be presented at the annual meeting of the society to be held on Friday, February 11.

THE annual meetings of the Institution of Naval Architects will be held on Wednesday, April 12, and the following day, in the hall of the Royal Society of Arts, John Street, Adelphi, W.C. Owing to the continuance of the war, the council has decided that it would be unsuitable for the customary entertainments to be given; the annual dinner and evening reception will accordingly not take place.

THE death is announced of Mr. F. M. Webster, a leading American entomologist, at the age of sixty-six. He was professor of entomology at Purdue University from 1885 to 1888, and had held various scientific official positions in connection with the States of Illinois, Indiana, and Ohio, as well as the Federal Department of Agriculture. At the time of his death he was in charge of the cereal and forage-crop insect

investigations of this department. One of his most important inquiries was that on which he was engaged from 1886 to 1890 in the solution of the problem of the buffalo gnat in the valley of the Lower Mississippi.

DR. E. W. HILGARD, who has died in California at the age of eighty-three, was a native of Rhenish Bavaria, but was taken to the United States by his parents in early childhood. His scientific studies were pursued at Heidelberg, Zurich, and Freiberg. He became successively State geologist of Mississippi, professor of chemistry at the University of Mississippi, and professor of geology at the University of Michigan. His chief work was done as professor of agriculture at the University of California from 1874 to 1904, and as director of the California Agricultural Experiment Station from 1888 to 1904. In 1875 he established the first experiment station in the United States. He also inaugurated the system of "farmers' institutes." He received the Liebig medal from the Munich Academy of Sciences, and a gold medal from the Paris Exposition of 1900. Dr. Hilgard was the author of numerous reports and monographs, dealing especially with the investigation of soils.

BY the death of Sir Francis H. Lovell on January 28 tropical medicine has lost one of its most ardent advocates. For a period of many years, as dean of the London School of Tropical Medicine, Sir Francis directed and encouraged a work of incalculable benefit to mankind. By missions to the East and to the West he was able to bring home to the dwellers in the tropics the value of a study of tropical diseases, and collected funds to a substantial amount for the endowment of the school. Francis Lovell began his life-work as Colonial Surgeon of Sierra Leone, 1873–78. He then became chief medical officer of Mauritius, and member of the Legislative Council, 1878–93, and was afterwards appointed Surgeon-General of Trinidad and Tobago, and member of the Executive and Legislative Councils, 1893–1901. He retired from the Colonial service in the latter year, and in 1903 became dean of the Tropical School, to the council of which he brought a ripe experience and a full appreciation of the value of scientific research. He was a fellow of the Royal College of Surgeons, was created C.M.G. in 1893, and received the honour of knighthood in 1900. A man of sterling worth and genial personality, his death leaves a blank which will not be filled easily.

THERE is now at the London Library a small but very interesting exhibit of early printed books on astronomy, from the collection of Mr. Gilbert R. Redgrave. Many of them are from the press of Erhard Ratdolt, whose fine work at Augsberg and Venice is so well known. There is a splendid copy of a "Kalendar" by Monteregio (otherwise Regiomontanus), in Italian, and an even finer one in Latin, both printed by Ratdolt at Venice in 1476—works now of great rarity. There is also a very rare folio tract by the same author, "Universis Bonarum Artium Studi," printed at Nuremberg in 1476. These appear to be in absolutely perfect condition. Among other fifteenth-century books mention may be made of a fine copy of Hyginus, "Poeticon Astronomicon," of 1487, as well as the less rare edition of 1488. The diagrams of eclipses, etc., are frequently coloured—some by hand and some printed in colours. Two works of later date, but of special interest, are Galileo's "Istoria e dimostrazioni," of 1613, describing the newly discovered spots on the sun, and announcing the configurations of Jupiter's satellites, and his "Dialogo" on the Ptolemaic and Copernican systems, which occasioned his condemnation by the Inquisition. The only English book is a fine copy of the first edition of Newton's "Principia" (1687).

ON the occasion of the establishment of the Willard Gibbs chair of research in pure chemistry in the University of Pittsburgh, Prof. M. T. Bogert delivered an address on the "Value of Research in Pure Chemistry," which is printed in *Science* (vol. xlii., No. 1091, p. 737). The part played by chemistry, "the intelligence department of industry," in bringing about the astonishing achievements of the last fifty years is sketched briefly but convincingly. Investigations in pure science laid those broad foundations upon which has been erected the wonderful structure of modern industrial operations. It will be recalled that two years ago, when in England, Prof. Bogert put forward the opinion that the most pressing need of the day was the proper endowment of chemical research by the providing of great research institutes and the creation of research professorships. Whilst it seems that in England these words had little effect, the United States are "beginning to awaken to the fact that civilisation unarmed by science is at a terrible disadvantage in the event of a struggle for existence, and that *this arming cannot be done at short notice*. The result is a loud and urgent call upon the universities, colleges, and technical schools of the land for help." The establishment of a chair of research in pure chemistry in so eminently a practical centre as Pittsburgh is an occasion for warmest congratulations. It is peculiarly appropriate that the new chair should bear the name of Josiah Willard Gibbs, who has been styled by Ostwald "by far the greatest man of science America has yet produced."

MANY representatives of chambers of commerce, with mayors, lord provosts, bankers, merchants, and business men attended a meeting held at the Guildhall, London, on Monday, to consider measures which should be taken after the war for the promotion of trade and commerce, and to deal with the subject of industrial employment. The Lord Mayor presided, supported by the Sheriffs and many members of the Corporation. The following motion, proposed by Sir Algernon Firth, president of the Association of Chambers of Commerce, was carried unanimously:—"That in the opinion of this meeting it is desirable that immediate steps be taken by his Majesty's Government, chambers of commerce, and other kindred associations, throughout the country, to formulate in close co-operation adequate action for the defence and improvement of trade and employment after the war, and with this object in view this meeting suggests full discussion of the fiscal, legislative, and voluntary efforts which ought to be made, and of the concentrated action and decisions which must be taken; and recommends the establishment of a Ministry of Com-

merce to carry out a constructive commercial policy for this country." In moving this resolution, Sir Algernon Firth said that the President and officials of the Board of Trade have every desire to promote trade, and within their powers are efficient; but they have many functions and are choked with administrative work. Frequently since 1869 chambers of commerce have urged the appointment of a Ministry of Commerce. Twice a resolution in its favour has passed the House of Commons, and in 1905 a Bill was promised in the King's Speech. It is essential to have a new Minister who will gather round him men of experience and judgment, and confine himself to steps to be taken after the war for the development of trade.

THE interest of the recently issued report of the Development Commissioners for the year ended March 31, 1915, lies not so much in its record of successful effort in the promotion of agricultural education and research, which have figured so prominently in former reports, as in its outline of the efforts of the commissioners to apply their energies and resources towards the practical necessities of the abnormal national situation which confronted them during the greater portion of the period under review. In the earlier days of the war, when widespread unemployment was generally anticipated, the attention of the commission was directed to the inception of preventive measures, but with the happy falsification of these fears it soon became necessary rather to discourage the inauguration of works requiring labour suitable for enlistment. At the same time, the commissioners have not lost sight of the possibility of a serious need for labour-employing works after the war, and have devoted their attention to the solution of the initial difficulties of certain projects of development, of which the construction of light railways, land drainage and reclamation, and afforestation are specified, with the view of ensuring that such schemes may be brought into operation quickly in case of emergency. The increase of the production and preservation of home-grown food supplies has been regarded as the chief question for immediate consideration, and substantial aid has been given to schemes designed to secure this end. The report contains much of interest with regard to the progress of schemes outlined in previous reports, but the amount of new work authorised and entered upon during the year was naturally but small. This is particularly the case in connection with the valuable scientific research work supported by the commission. It is gratifying to note, however, that no effort has been spared to ensure the continuity of the work of the newly-founded research institutes, although the inevitable depletion of staffs has necessarily greatly curtailed their activities.

THE *Psychological Bulletin* (vol. xii., No. 12) summarises in a useful form the recent published work on social and religious psychology. Perhaps the section of widest general interest is that relating to the causes and treatment of crime. All students of social problems, whether from the theoretical or practical point of view, will find much that is of value in this number. If the relation between crime and feeble-mindedness, for example, were realised more consciously, then as a corollary the State treatment of the criminal would have to be modified. Progress in criminal legislation is being made slowly, but the need for a definitely scientific study of those social phenomena we vaguely subsume under the concept of crime is still insistent.

THE Bureau of American Ethnology has for some time employed Miss Frances Densmore on the task of collecting by means of the phonograph the music of the Indian tribes. About one thousand songs have already been recorded. Many of those procured from the Chippewas have to do with the belief in the Mide, or Great Medicine, the object of the ritual being to secure health and long life for its members, and to promote temperance and other virtues. Many of the songs were handed down by tradition, and the singers were assisted by a system of mnemonics recorded on a strip of birch bark. A collection of songs, known as "Dream Songs," are said to have come to the Indians in the course of dreams and trances. These are used in treating the sick. One of their medicine-men demonstrated his supernatural powers by feats of jugglery, releasing himself from bonds in a manner familiar to European performers. Indian music, except the songs of daily life, is closely connected with the supernatural, and hence it is carefully guarded by the people.

THE important piece of apparatus known as the respiration calorimeter was invented by Atwater and Benedict at Middletown, Connecticut, in 1892. Since that time the instrument has played an important part in investigations on the metabolism in man and other animals. Many improvements have been introduced, and the present form of the Atwater apparatus is now installed at Boston in a building specially devoted to metabolic research under the supervision of Prof. F. G. Benedict. Modifications are also set up in New York and various other American universities, and the latest form of improvement has just been described by Drs. Longworthy and Milner, of the Home Economics Department at Washington. This is fully described and figured in the *Journal of Agric. Research* issued by the United States Department of Agriculture (November 22, 1915). Various other changes have been introduced from time to time to suit other animals than men. In this country the unfortunate lack of funds which characterises all efforts in research has prevented the prosecution of this branch of work. So far as we are aware, there is only one respiration calorimeter in Great Britain, and this was set up by Prof. Macdonald at Sheffield University. When it is possible to divert funds from the present urgent necessities of the country, we trust that the installation of respiration calorimeters will not be neglected.

THE annual report of the Dominion Museum of New Zealand for 1915 contains some valuable notes on the Tuatera "lizard" (*Sphenodon punctatus*), which have been furnished by the lighthouse-keepers and others on Stephen Island, The Brothers, Cuvier's Island, and the Little Barrier bird sanctuary. To judge from these reports, it would seem that a great deal of un-

necessary slaughter, in regard to "hawks," is going on, and under official recognition. The hawks, which are diurnal birds, are accused of preying on the Tuateras, which are nocturnal. The real culprits, it would seem, are feral cats, of which considerable numbers have been killed. If these ancient reptilia are to be preserved, a much more carefully thought-out scheme of protection must be devised. So far as the evidence furnished by this report allows one to judge, it would seem that the haunts of these animals are not sufficiently protected by scrub. If this could be appreciably increased and the cats exterminated, the Tuatera would probably need little further protection.

THE curious habit which certain minute "Chloropid" flies have of entering human habitations in vast swarms, apparently for the purpose of hibernating, has long been known. A further instance is now recorded in the *Entomologist's Monthly Magazine* for January by Mr. Hugh Scott. In this case a house about six miles from Cambridge was invaded in October last by myriads of these flies, causing great discomfort to the occupants. They occurred in two rooms only, facing the south-east, and were clustered in seething masses along the bars of the window-panes, and on the ceiling immediately above the window. Samples of the swarm proved to consist mainly of a small yellow Chloropid (*Chloropisca ornata*) and a slightly larger Anthomyid (Spilogaster), but intermingled with these were several larger species, and a few wasps. These two rooms have been invaded after this fashion for at least five or six years in succession, and in every case that on the first floor has proved the most attractive. For some quite inexplicable reason Cambridge has suffered more from this plague than any other place in England. So far back as 1831 an enormous swarm invaded the Provost's lodge at King's College, and the visitation was repeated in 1870, while of late years similar swarms have occurred in certain apartments of the museums which are near King's College, and always in the same apartments. No clue whatever as to their origin has yet been obtained.

THE current number of the Journal of the Quekett Microscopical Club (Ser. 2, vol. xii., No. 77) contains an interesting note by Mr. James Burton on the freshwater alga, *Hydrodictyon reticulatum*. This remarkable plant, which takes the form of a net, floating in the water, is not very often seen in this country. For more than thirty years Mr. Burton looked for it almost in vain, though it was known to have occurred in past times in the lake in Kew Gardens. In the autumn of 1914, however, it made its appearance in that locality in enormous quantities, so that boatmen were employed in gathering it in with rakes and piling it in heaps on the shore. In less than a month's time after first seeing it Mr. Burton was unable to find a single specimen. He compares this sudden outburst of Hydrodictyon to the so-called "breaking of the meres," caused by the sudden and rapid multiplication of other algæ. The same number also contains an obituary notice, accompanied by an excellent portrait, of the late Prof. E. A. Minchin, a former president of the club.

THE Indian jute industry formed the subject of a recent lecture by Mr. C. C. McLeod before the Royal Society of Arts, and this is now printed in the *Journal*, No. 3292, vol. lxiv., for December 24 last, with a number of illustrations showing the cultivation and mode of preparation of jute. In Bengal, Cooch Behar, and Assam more than 3,350,000 acres are under jute cultivation, and the value of raw jute exported in 1913 amounted to 20,000,000*l*. It was not until 1855 that a jute mill was started at Calcutta, and now the mills there turn out nearly 3000 tons of the manufactured article per day.

THE report of the agricultural department, Montserrat, for 1914–15 shows a satisfactory condition in the island's present position and future prospects. A definite attempt is being made to establish an onion trade in the island for the Canadian market, which promises to be successful. The bay oil industry is also receiving particular attention. Valuable work in cotton selection is being continued at the botanic station, and seed of high and uniform quality from types in the island is being selected for estate planting.

THE *Indian Forester* for November, 1915, vol. xli., No. 11, contains the first part of an interesting article on forest administration in Bashahr, the largest of the Simla Hill States. The State for its greater area lies within the drainage area of the Sutlej river, and consists of precipitous mountain country with narrow ravines. The deodar and blue pine (*Pinus excelsa*) are the prevalent trees, and the article is illustrated by photographs of some fine specimens of deodars. Girth measurements of more than 35 ft. are recorded, but the average girth in the forests is 15 ft., with height measurements of 120–150 ft. Some good pictures of the precipitous mountain-sides are also included. Mr. Glover gives a history of the forests, which have only been known since 1850. The destruction by fires and improper felling has been very great, especially about the year 1862, when scarcely a quarter of the trees felled ever reached the sale depôts, and it was estimated by Brandis that, between 1859 and 1863, 30,000 deodars had been felled from the more accessible forests. Now that the forests are under the forest service, conservation is being practised, and the natural regeneration is proceeding properly.

Symons's Meteorological Magazine for January, 1916, gives a tentative rainfall total for December, 1915, over the British Isles obtained from a representative selection of stations. The rainfall was everywhere in excess of the average except at a few stations in Scotland. The excess was greatest in the south-east and east of England, where in many places the rainfall was more than 250 per cent. of the average. At Arundel the rainfall was 289 per cent. of the average, and in London it was 255 per cent. The largest amount of rain was 21·03 in. at Borrowdale, in Cumberland, and the least was 3·43 in. at Geldeston, in Norfolk. The rainfall map for the Thames Valley shows the month to have been exceedingly wet, the rainfall values over the area rang-

ing from about 10 to 4 inches. The general rainfall for England and Wales was 198 per cent. of the average, for Scotland 135 per cent., for Ireland 158 per cent., and for the British Isles as a whole 169 per cent. of the average. A tentative result for the whole of 1915 is also given.

THE Bulletin of the American Geographical Society for November (vol. xlvii., No. 11) contains two papers of considerable geographical value referring to people in relation to their environment. The first, by Mr. L. Dominian, deals with the peoples of northern and central Asiatic Turkey. The complexity of races in that region is analysed, and the results are shown on a coloured map. Another coloured map gives the distribution of Armenians in Turkish Armenia. The second paper is by Dr. J. Russell Smith, and discusses the adjustment of the Bedouin to his surroundings. Though it contains few new facts, it is of value for its fresh interpretation of the relations of place and people. Both papers are well illustrated.

SOME years ago Mr. G. H. Girty began to make a systematic study of the Carboniferous faunas of North America, and he has now completed a description of the fossils of the Wewoka formation in Oklahoma (Bulletin of the United States Geological Survey, No. 544). This formation is especially interesting because it is far distant from the well-known Carboniferous areas further north and east, and both its sediments and its faunas show marked differences from those already studied. Most of the fossils are in a fine state of preservation, and are found weathered out of the shales. The Mollusca are especially abundant, and the Brachiopoda do not predominate so much as usual. The beautiful figures which illustrate the descriptions will be welcomed by students of Carboniferous fossils.

DR. J. W. EVANS has drawn up for H.M. Stationery Office a very useful pamphlet (price 2*d*.), entitled "Directions for the Collection of Geological Specimens." The concluding paragraph suggests that it is intended for travellers in our colonies; but it will also be found of service by those who have any leisure in our war-zones, and by students and surveyors in the British Isles. The author's experience in various continents enables him to give admirable advice on larger questions than mere collecting, such as inquiries on water supply and physiographic changes in recent times. As an example of his thoroughness, we may note his suggestion of marking strike and dip on a bedded specimen where these are of interest. The lines and figures on the specimen will then permanently record its position in the mass from which it came.

THE railway development of Africa is the subject of a useful article and map by Sir Charles Metcalfe in the *Geographical Journal* for January (vol. xlvii., No. 1). The article contains a great deal of matter in small compass. The present railways are largely feeders of rivers, or independent lines to seaports, but many projects are on foot to make the railways continuous, when the navigable reaches of the rivers will become their feeders. There will be through communication between Port Said and Cape Town by rail and steamer when the line in the Congo is finished from Kambove to Bukama, and from Stanleyville to Lake Albert, and the short section of 100 miles from Dufile to Rejaf. From Stanleyville it is probable that a line will be built to Lake Chad and continued to link up with the French Trans-Sahara railway. An alternative Cape to Cairo route will be from Broken Hill in Rhodesia, on the existing line, to the south end of Tanganyika, through what is now German East Africa to the existing Uganda railway and thence to Senaar in the Sudan. The rapidly constructed link between the Cape railways and those of the protectorate of South-west Africa are shown on the map.

THE *Educational Times* has long been the medium adopted by a certain class of mathematicians when they wish to derive what pleasure there is to be derived from puzzling over riddle-me-rees in the form of mathematical problems. From the commencement of the present year these things are transferred to a separate publication, which is to be issued monthly under the title of *Mathematical Questions and Solutions*. It is edited by Miss Constance Marks and published by Mr. Francis Hodgson, 89 Farringdon Street, London, the subscription price being 5*s*. for six months, including postage and binding cover. It contains the usual series of out-of-the-way properties of conics, triangles, and collections of algebraic symbols, and the usual neglect of aeroplanes. The latter would with very little difficulty provide enough problems to keep a journal of this kind going almost indefinitely, but aeroplanes have always been tabooed by the British mathematical world. The possibility, however, suggests itself of using the journal as a medium for getting some of the analytical details of these investigations solved by reducing them to problems in pure mathematics.

THE *Mathematical Gazette* for January contains a "bordered antilogarithm table" drawn up by Prof. G. H. Bryan and Mr. T. G. Creak. In the description the authors claim that the object of the table is to enable logarithms, logarithms of reciprocals, and antilogarithms of numbers and their reciprocals all to be taken from the same table. To do this they use a table of antilogarithms or powers of ten, with the complementary logarithms entered in the right-hand column and the bottom of the page in the same way that the ordinary trigonometric tables avoid duplication in tabulating logarithmic sines and cosines. Another feature on which the authors lay great stress is that the antilogarithms are tabulated to five significant figures in the lower parts of the scale and to four in the higher parts. This degree of approximation is both necessary and sufficient to secure the maximum degree of accuracy in working with four-figure logarithms, as the tabular differences are neither too small nor unnecessarily large.

THE *Revue générale des Sciences* for December 30, 1915, contains a well-illustrated article by M. Jacques Boyer on the manufacture of X-ray tubes in France during the war. The bulbs of the modern tubes are

much larger than they were a few years ago, and the rays they produce will penetrate several centimetres of steel, and allow a radiograph of the thickest part of the body to be taken by means of a tube three metres away. At the commencement of the war the military authorities requisitioned all the X-ray tubes in France, but as this supply was found insufficient for the proper equipment of the radiological stations, the two French manufactories, which had been closed owing to their directors being called to the colours, were reopened, in one case by the recall of the director from the front, in the other by the appoinment of a member of the Academy of Sciences as director. Under the guidance of a professor of the Collège de France a firm of glass-makers began the manufacture of the special glass for the bulbs, and in a few days was turning out the necessary quantity, so that France is now producing sufficient X-ray tubes to meet her own requirements, and is supplying some to her Allies.

THE essentials in the manufacture of a good rheostat are the use of first-class material and workmanship of a high grade. This useful piece of apparatus should therefore be particularly a British product; the rheostat cannot be considered to be a "competitive" article or one lending itself particularly either to what the Germans term "Massenfabrikation" or to dumping. Yet Messrs. Isenthal and Co., in sending us a new list of their rheostats, frankly admit that they had previously imported these from abroad, but are now manufacturing them entirely in England. The list before us is one of the most complete we have seen. Both the flat slate and the tubular types have hand-shield sliders with well-designed contact-makers, and the number of different arrangements listed should meet practically every requirement. A useful variation from the ordinary flat type is one with limbs of cross-shaped section which affords increased ventilation and enables the maximum number of watts to be dissipated for the minimum dimensions without undue heating. In the tubular type the slate bars are replaced by fire-enamelled steel tubes, and the resistance wire is oxidised so that the insulation of the oxide enables the turns to be wound closely. Dimensions, approximate resistances, weights, and diagrams of connections and arrangements of the terminals are given in detail, so that it should be possible to order rheostats for almost any purpose directly from the catalogue. We trust that Messrs. Isenthal and Co. will continue to manufacture them in England after the war.

THERE is a description of one of the new British projectile-making factories given in *Engineering* for January 28, illustrated by several good photographs showing some of the shops. The nine bays of the factory cover about 196,600 sq. ft., and are arranged so as to reduce to the minimum the distance which the shell has to travel in the process of manufacture. From the entry of the rough bar to the finished shell ready to be put into the breech of a gun, the distance travelled is only 400 yards. There are nearly one hundred operations in making a shell, and many of these take but little time; hence it is important that the time spent in moving the shell from operator to operator should be as small as possible. Small shells are machined in this factory by female workers, and there are 1800 women in this department. The girls are able to work the machines in three days, and are efficient in seven days; the highest efficiency is attained after two months' experience. One skilled worker suffices for the setting of the machines for twelve female operators. The accuracy demanded is 0·004 in., and it speaks well for the girls that the rejected shells do not amount to more than one per cent.

OUR ASTRONOMICAL COLUMN.

THE SOLAR ECLIPSE OF FEBRUARY 3, 1916.—Official European observatories have perforce had to refrain from participating in the observation of to-day's total solar eclipse, notwithstanding the fact that spectroscopic interest was so unexpectedly intensified by the change recorded in the coronal spectrum at the eclipse of August 21, 1914. From the success that then attended the Spanish expedition, it might almost have been expected that the Madrid observers, at any rate, would have attempted to take advantage of the present opportunities. It would appear, however, that the American observers will have the field to themselves.

Starting in the Pacific Ocean, February 3d. 2h. 29m. G.M.T., in long. 121° 35·6′ W., lat. 7° 20·8′ N., almost a minimum part of the central line of totality passes over land areas. This portion is nearly parallel to and somewhat north of the Bogota-Caracas line in Columbia and Venezuela. The line then crosses the Caribbean Sea to Guadeloupe. The duration of totality over all this section is about 2½ minutes; the maximum of 2m. 36s. is reached before quitting Venezuela. Sweeping across the Atlantic, centrality passes a little wide of the Azores, and ends about 200 miles off the south coast of Ireland (Mizen Head) at 5h. 31·0m., in long. 9° 50·2′ W. and lat. 49° 23·8′ N. A partial eclipse will consequently be visible over the greater part of the Americas.

In south-west Europe, north-west Africa, and the British Islands the eclipse will only be partly visible, the sun setting in partial eclipse. At Greenwich the eclipse begins at 4h. 31m., and the sun sets at 4h. 49m., with about one-quarter of the disc obscured. The magnitude of the eclipse increases as the observer is situated further west, until in the south-west of Ireland the obscuration reaches about nine-tenths of the disc.

COMET 1915*e* (TAYLOR).—Prof. E. Strömgren has sent to NATURE his latest observation of the position of this comet, made on January 23. At 5h. 47m. 6s. G.M.T. the comet's position was α app., 5h. 10m. 1·89s., δ app. +16° 56′ 54·1″, whence the corrections of the ephemeris of Copenhagen Circular No. 11, $\Delta\alpha$=0s., $\Delta\delta$ = +0·8′ The comet is stated to have been of the eleventh magnitude.

COLOURS OF STARS IN THE CLUSTERS N.G.C. 1647 AND M. 67.—The first statistical investigation employing the colour classes recently proposed by Prof. F. H. Seares deals with the distribution of colours among the stars in the above clusters (Proc. Nat. Acad. of Sci., i., p. 483). Hertzsprung and Seares have respectively published effective wave-lengths and colour indices for a number of the stars in N.G.C. 1647 (NATURE, September 23, 1915). Hertzsprung's results were alone taken into account, leading to the following correspondences between effective wave-length and colour class:—

Effective w.l.	4190	4260	4330	4400	4470	4540
Colour class	bo	ao	fo	go	ko	mo

N.G.C. 1647 is principally made up of *a* and *f* stars, but contains a number of *b* and also some *km*, whilst

M. 67 (colour indices measured by Shapley) appears to be almost entirely made up of *g* stars, and contains neither *b* nor *m* classes, reminding us forcibly of the frequent association of the corresponding spectral types among the isolated stars.

Very significantly, in neither case does colour or magnitude vary with condensation. On the other hand, colour and magnitude are found to be connected, showing a marked relationship in the case of N.G.C. 1647, less pronounced in M. 67.

THE COLUMBUS MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE sixty-eighth annual meeting of the American Association for the Advancement of Science was held at Columbus, Ohio, from December 27, 1915, to January 1, under the presidency of Dr. W. W. Campbell, director of the Lick Observatory of the University of California. In spite of the fact that the second Pan-American Scientific Congress was held at the same time in Washington, D.C., there was an attendance of something more than eight hundred, and the meeting was unusually successful.

The address of the retiring president, Dr. C. W. Eliot, on the subject, "The Fruits, Prospects, and Lessons of Recent Biological Science," has already been printed in NATURE (January 27, p. 605). Addresses of presidents of sections were given as follows:—(A) H. S. White, "Poncelet Polygons"; (B) A. Zeleny, "The Dependence of Progress in Science upon the Development of Instruments"; (F) F. R. Lillie, "The History of the Fertilisation Problem"; (G), G. P. Clinton, "Botany in Relation to American Agriculture"; (H) C. Wissler, "Psychological and Historical Interpretations of Culture"; (I) E. E. Rittenhouse, "Upbuilding American Vitality: the Need for a Scientific Investigation"; (K) R. M. Pearce, "The Work and Opportunities of a University Department for Research in Medicine"; (L) P. H. Hanus, "City School Superintendents' Reports"; (M) L. H. Bailey, "The Forthcoming Situation in Agricultural Work."

One of the most interesting functions of the meetings was a public lecture complimentary to the citizens of Columbus by Dr. D. W. Johnson, professor of physiography at Columbia University, on "Surface Features of Europe as a Factor in the War." Dr. Johnson indicated the strategic reasons for the movements in the great war which have been dependent upon the character of the country involved, and threw a new light on the subject to those who have been puzzled especially by the operations in the eastern war zone. Other public lectures were delivered by Dr. R. F. Bacon, of the Mellon Institute of Pittsburgh, on "The Industrial Fellowships of the Mellon Institute: Five Years' Progress in a System of Industrial Service"; Dr. F. K. Cameron, of the Bureau of Soils, Washington, "The Fertiliser Resources of the United States."

An important symposium on the topic, "The Basis of Individuality in Organisms," was held by Section F and the American Society of Zoologists.

Section K conducted a symposium on the topic, "Foods and Feeding," in the course of which Prof. H. B. Armsby spoke of the "Energy Content of the Diet"; Prof. Ruth Wheeler on the "Effect of the Proteid Constituents of the Diet on Growth"; Prof. E. B. Forbes, "The Mineral Nutrients in Practical Human Dietetics"; Prof. Carl Voegtlin, "Vitamines"; Dr. C. F. Langworthy, "Food Selection for Rational and Economical Living."

The new section of Agriculture, Section M, conducted a symposium on the topic, "The Relation of Science to Meat Production," in which President W. O. Thompson (Ohio State University), President H. J. Waters (Kansas State Agricultural College), Prof. L. D. Hall (Office of Markets, U.S. Department of Agriculture), Prof. H. W. Mumford (University of Illinois), and Dr. A. R. Ward (Bureau of Animal Industry, U.S. Department of Agriculture) took part.

The following affiliated societies met with the American Association for the Advancement of Science:—American Association of Economic Entomologists, American Mathematical Society, American Microscopical Society, American Nature-Study Society, American Physical Society, American Phytopathological Society, American Society of Naturalists, Association of Official Seed Analysts of North America, Botanical Society of America; Entomological Society of America, Society for Horticultural Science, Southern Society for Philosophy and Psychology, Students and Collectors of Ohio Archæology; Wilson Ornithological Club.

New York was chosen as the meeting place for Convocation Week of 1916–17.

Dr. C. R. Van Hise, president of the University of Wisconsin, a distinguished geologist, was elected president of the association for the next year. The vice-presidents—that is, presidents of sections—elected were as follows:—Mathematics, L. P. Eisenhart, Princeton University; Physics, H. A. Bumstead, Yale University; Engineering, E. L. Corthell, Brown University, Providence, R.I.; Geology and Geography, R. D. Salisbury, University of Chicago; Zoology, G. H. Parker, Harvard University; Botany, T. J. Burrill, University of Illinois; Anthropolgy and Psychology, F. W. Hodge, chief of the Bureau of Ethnology, Washington, D.C.; Social and Economic Science, Louis I. Dublin, New York; Education, L. P. Ayres, of the Russell Sage Foundation, New York; Agriculture, W. H. Jordan, director of the New York State Experiment Station, Geneva, N.Y.

The general committee reaffirmed the recently adopted policy of the association in regard to the planning of future meetings, establishing a five years' schedule, largely for the benefit of the affiliated societies in making their plans for the future.

Members of the association who attended the last Columbus meeting in 1899 were greatly impressed by the growth of the Ohio State University during the intervening years, a growth, however, which is characteristic of a number of the great State universities in the United States. At the time of the 1899 meeting there were only one thousand students at this University, and at the time of the present meeting there are more than five thousand. Very many new buildings have been erected in the interim, and the equipment of all is modern and most excellent.

PARIS ACADEMY OF SCIENCES: PROPOSED PRIZES AND GRANTS.

PRIZES PROPOSED FOR 1917.

Mathematics.—The Francœur prize (1000 francs) will be awarded to the author of discoveries or works useful to the progress of pure or applied mathematics; the Bordin prize (3000 francs), for an improvement in some important point of the arithmetical theory of non-quadratic forms; the Poncelet prize (2000 francs), to the French or foreign author of the most important work in applied mathematics published in the course of the preceding ten years; the Vaillant prize (4000 francs), the question set for 1917 is to determine and study all surfaces which can in two different ways be formed by the displacement of an invariable curve.

Mechanics.—The Montyon prize (700 francs), for inventing or improving instruments useful to the pro-

gress of agriculture, mechanical arts, and the practical and speculative sciences; the Fourneyron prize (1000 francs), for the theoretical and experimental study of the question of combustion or explosion turbines; the Pierson-Perrin prize (5000 francs), for a discovery in mechanics.

Astronomy.—The Pierre Guzman prize (100,000 francs), to anyone finding a means of communication with a planet other than Mars, that is to say, to make a signal and receive a reply; the Lalande prize (540 francs), for observation or memoir most useful to the progress of astronomy; the Valz prize (460 francs), for similar work; the G. de Pontécoulant prize (700 francs), for the encouragement of researches in celestial mechanics; the Damoiseau prize (2000 francs), question for 1917, to calculate more exactly, taking the results of recent expeditions into account, the attraction of the moon on the wave formed at the surface of the earth by the tides. To examine the effect of this attraction on the angular velocity of the earth's rotation.

Geography.—The Tchihatchef prize (3000 francs), for the recompense or assistance of explorers in Asia (excluding British India, Siberia, Asia Minor, and Syria). The explorations may have as an object any branch of mathematical, physical, or natural science, excluding such sciences as archæology, history, ethnography, and philology. The work must result from actual observations made on the spot. Gay prize (1500 francs), the question proposed is the geographical distribution of tropical and subtropical plants presenting practical interest.

Navigation.—The extraordinary prize of 6000 francs for any progress of a nature as to increase the efficacy of the French naval forces; the Plumey prize (4000 francs), for the author of improvements in steam engines or any other invention contributing to the progress of steam navigation.

Physics.—The Hébert prize (1000 francs), for the best treatise or work for the popularisation and practical employment of electricity; the Hughes prize (2500 francs), for an original discovery in the physical sciences, especially electricity and magnetism and their applications; the Henri de Parville prize (1500 francs), for original work in physics; the Gaston Planté prize (3000 francs), for an important invention or work in the field of electricity.

Chemistry.—The Jecker prize (10,000 francs), for works leading to progress in organic chemistry; the Cahours prize (3000 francs), for the encouragement of young chemists who have already published good work; the Montyon prize (unhealthy trades; a prize of 2500 francs and a mention of 1500 francs), for a means of rendering an art or calling less unhealthy; the Houzeau prize (700 francs), for rewarding a promising young chemist; the Berthelot prize (500 francs), for researches in chemical synthesis.

Mineralogy and Geology.—The Delesse prize (1400 francs), for work in geology or mineralogy; the Joseph Labbé prize (1000 francs), for geological work or researches contributing to the mineral wealth of France, its colonies, or dependencies; the Victor Raulin prize (1500 francs), for work in geology or palæontology; the Fontannes prize (2000 francs), to the author of the best palæontological publication; the James Hall prize (700 francs), for the best thesis for the doctorate in geology during the last five years.

Botany.—The Desmazieres prize (1600 francs), for the best work published during the preceding year on Cryptogams; the Montagne prize (1500 francs), for work bearing on the anatomy, physiology, development, or description of the lower Cryptogams; the de Coincy prize (900 francs), for work on Phanerogams; the Thore prize (200 francs), for the best work on the cellular Cryptogams of Europe; the Jean de Rufz de Lavison prize (500 francs), for work in plant physiology.

Anatomy and Zoology.—The Savigny prize (1500 francs), for the assistance of young travelling zoologists, not in receipt of Government grants, and who occupy themselves with the invertebrates of Egypt and Syria; the Cuvier prize (1500 francs), for work in comparative anatomy and zoology.

Medicine and Surgery.—The Montyon prize (a prize of 2500 francs, mentions of 1500 francs), for works most useful in the art of healing; the Barbier prize (2000 francs), for a valuable discovery in surgical, medical, or pharmaceutical science, or in botany in relation to medicine; the Bréant prize (100,000 francs), for a radical cure for Asiatic cholera; the Godard prize (1000 francs), for the best work on the anatomy, physiology, and pathology of the genito-urinary organs; the Baron Larrey prize (750 francs), for the best work on the subjects of medicine, surgery, or military hygiene; the Bellion prize (1400 francs), for works or discoveries "profitable to the health of man or to the amelioration of the human species"; the Mège prize (10,000 francs), for the continuation and completion of Dr. Mège's essay on the causes which have retarded or favoured the progress of medicine from antiquity down to the present time; the Argut prize (1200 francs), for a discovery of a cure for a disease which at present can only be treated surgically, thus enlarging the domain of medicine.

Physiology.—The Montyon prize (750 francs), for work in experimental physiology; the Philipeaux prize (900 francs), for the same; the Lallemand prize (1800 francs), to recompense or encourage works relating to the nervous system in the widest sense; the Pourat prize (1000 francs), the subject proposed is the relations of the combined sugar of the blood with the albumenoid materials; the Fanny Emden prize (3000 francs), for the best work dealing with hypnotism, suggestion, and generally with physiological actions which can be exercised on the animal organism at a distance.

Statistics.—The Montyon prize (prize of 1000 francs and two mentions of 500 francs).

History and Philosophy of the Sciences.—The Binoux prize (2000 francs).

General Prizes.—The Arago medal; the Lavoisier medal, for eminent service in chemistry; the Berthelot medal, awarded each year to the prizewinners in the subject of chemistry; the Henri Becquerel foundation (3000 francs); the Gegner prize (3800 francs); the Lannelongue foundation (2000 francs), for the assistance of one or two persons in reduced circumstances who belong to the scientific world, either themselves or by marriage or by parentage; the Gustave Roux prize (1000 francs); the Trémont prize (1000 francs); the Wilde prize (one prize of 4000 francs, or two of 2000 francs), for a work or discovery in astronomy, physics, chemistry, mineralogy, geology, or experimental mechanics; the Lonchampt prize (4000 francs), for the best memoir on diseases of man, animals, or plants, from the special point of view of the introduction of mineral substances in excess as the cause of these diseases; the Saintour prize (3000 francs), for work in mathematical science; the Henri de Parville prize (2500 francs), for a book dealing either with original work or with the popularisation of science; the Vaillant prize (4000 francs), (see under mathematics); prize founded by the State (3000 francs); grand prize of the physical sciences, subject proposed for 1917, the modifications presented by trypanosomes in the bodies of insects; the Petit d'Ormoy prize (two prizes of 10,000 francs), one for pure and applied mathematics, and one for the natural sciences; the Serres prize (7500 francs), for works on general embryology, applied so far as possible to physiology and

medicine; the Alhumbert prize (1000 francs), question proposed for 1917, the study of the action of the magnetic field on crystalline liquids; the prize founded by Mme. la Marquise de Laplace, to the pupil holding the first place leaving the Ecole Polytechnique; the Fêlix Rivot prize (2500 francs), between the four pupils leaving the Ecole Polytechnique with first and second places in mines and *ponts et chaussées*.

The Loutreuil Foundation.

As this is the first distribution of this fund, a summary is given of the regulations formulated by the committee for dealing with applications.

The grants recommended fall into three classes:—

(1) To institutions specially mentioned in the will of the founder.

The Natural History Museum, 1000 francs for the continuation of researches on orchids undertaken by Prof. J. Costantin, and 5700 francs for the purchase of accumulators, and 4300 francs for a radiographic installation needed in the laboratory of Prof. Jean Becquerel.

The Collège de France, 4000 francs to G. Gley, for the installation of an apparatus in his laboratory for the production of cold; 5000 francs to L. Cayeux, for completing the equipment of his geological laboratory for petrographical researches; 2400 francs to M. Müntz, director of the laboratory of vegetable chemistry of Meudon; 2000 francs to L. Nattan-Larrier for the purchase of a centrifuge and incubator for cultures of micro-organisms.

As the provincial observatories are all attached to the universities which have already received a special legacy from M. Loutreuil, the council will only consider claims for grants relating to researches of a personal order. Under this head 3000 francs is granted to M. Gonessiat, director of the Algiers Observatory, for the construction of an apparatus designed to measure the intensity of Hertzian waves and for a vertical seismograph.

Polytechnic School, 3000 francs to E. Carvallo, for the continuation of his researches on a method of shooting at airships.

The veterinary schools of Lyons and Alfort, each 5000 francs, for the upkeep of their libraries; the veterinary school of Toulouse, 3000 francs for the same purpose, and 1000 francs to M. Montane, for the reorganisation of the anatomical collections of this school.

(2) To institutions admitted by the president of the academy to participate in grants from the Loutreuil Fund.

The Conservatoire des Arts et Metiers: 3000 francs to Marcel Deprez, for his experiments relating to the transmission of the heat of gases to metallic walls, constantly cooled, and for experiments on electrical phenomena arising from internal-combustion motors; 4500 francs to A. Job, for the purchase of a calorimetric bomb, an electric transformer, and other apparatus necessary to his researches on the velocities of oxidising reactions; 6000 francs to Jules Amar, for improving his equipment for the study of the muscular forces of man at work by the graphic and chronophotographic methods.

(3) To other societies and to individuals.

The Société de documentation bibliographique, 2000 francs; 2000 francs to Henri Piéron, for the equipment of his laboratory at the Sorbonne for physiological psychology; 2400 francs to Louis Mengaud, professor at the Lycée of Toulouse, for exploratory work in the province of Santander; 10,000 francs to Charles Marie, for assistance in the publication of tables of physical constants; 3000 francs to Camille Flammarion, for his private observatory at Juvisy; 4000 francs to Emile Miège, for experiments at Rennes; 1000 francs for the preparation of plates illustrating fossils collected by J. Couyat-Barthoux.

The total grants recommended amount to 82,300 francs, and this does not exhaust the sum available. During the war it has been impossible for all the investigators to carry on work already commenced or to undertake new researches, and other expenditure considered desirable by the council has been excluded by the terms of the legacy.

BRITISH METEOROLOGY.[1]

OWING to the war every side of the work of the Meteorological Office has been affected, and many alterations in the staff have taken place, although it is highly satisfactory to note that in this period of emergency the office has risen in every way to the ever-increasing demands made on it by the Admiralty. This high efficiency is the outcome of the progressive development, organisation, and co-ordination of the work in all the divisional sections of the office and of the observations attached to it, gradually and systematically carried out, under the direction of Sir Napier Shaw, in the years preceding the outbreak of hostilities. Although all branches have supplied their quota of indispensable information to the authorities, the services rendered by the forecast division are more conspicuous than in other directions, so that it occasions no surprise to read that this division "has not failed to meet promptly and efficiently whatever wishes the Admiralty has expressed for information as to the weather over any part of the British Isles and neighbouring seas, for the use of the Navy, the Air Department, or the officials at headquarters."

The C.G.S. system of units for the expression of meteorological measurements has continued to make headway, and is being gradually introduced into all the publications. In this connection it is noted that the substitution of the millimetre for the inch in the measurement of rainfall "has met with less appreciation" than the other radical changes in progress. The necessity of uniformity is well shown by the publication of data dealing with the meteorology of the globe for 1911 on the basis of two stations for each 10° square, which is at present passing through the press under the title of the "Réseau Mondial, 1911." In this publication pressure is given in millibars, temperature in degrees absolute, and rainfall in millimetres for all stations.

A request received early in 1914 through the Foreign Office and the Board of Agriculture and Fisheries regarding the application in this country of meteorology to agriculture, forms the subject of an exhaustive reply given *in extenso* in appendix 2. It is pointed out that the line hitherto taken by the Meteorological Office, "as guided by tradition and precedent," has been to supply information likely to be of value to agriculturists in the form of weather forecasts and statistical reports, leaving the application of the data to the problems on hand to any who are disposed to take advantage of the material provided. The office resources do not include a staff to elucidate the questions involved, and a similar position obtains at the Board of Agriculture and Fisheries. The data provided are but little used by agriculturists. "Many persons are willing to receive forecasts by telegraph, but are unwilling to pay for the telegrams," and as the British race is not in the habit of paying for anything until its value has been amply demonstrated, both the Government and the farmer are waiting for the prac-

[1] Tenth Annual Report of the Meteorological Committee to the Lords Commissioners of His Majesty's Treasury for the Year ended March 31, 1915. Pp. 91. (London: H.M.S.O.; Wyman and Sons, Ltd., 1915.) Price 5½*d*.

tical value of the forecasts to be established. This can only be done by trial, and both sides are waiting for the other to demonstrate, beyond cavil, the value of the information to be supplied. The fundamental difficulty seems to be that the farmer has made his own study of the weather, and uses it in his own way without committing the results to writing, while the Meteorological Office prints large masses of data without knowing precisely in what directions to discuss them in relation to agricultural problems.

Appendix 4 deals with proposals for the establishment of a "Central Observatory for the Investigation of the Upper Air," in which it is pointed out that since 1905 the small sum of 450*l.* a year has been available for the purpose of upper air research. Having in view the great and rapidly growing importance of the aeronautical and aerological aspects of the work, especially in relation to aviation, it is to be hoped that this scheme will go through. The services rendered by Mr. W. H. Dines, F.R.S., in the past are so well known that the mere mention of them is an ample guarantee that the annual appropriation of some 1000*l.* to 1500*l.* proposed would be money well expended. The site suggested is at Benson, in Oxfordshire, which has many advantages to recommend it as a position for the central aeronautical observatory contemplated.

THE NATURE OF EXPLOSIVES.

IT was suggested in the review of Mr. A. Marshall's important work on "Explosives" in NATURE of June 3, 1915 (vol. xcv., p. 366) that the book would be improved if it had an introductory chapter dealing with the general principles on which the composition and action of explosives depend. Mr. Marshall, writing from Naini Tal, India, says that he had prepared a chapter on the lines suggested for another shorter work of a less technical character than that which was the subject of our review. Unfortunately, through pressure of other work, he has been obliged to postpone for the present the completion of this book, but he sends us the chapter; and we are glad to publish it as a separate article, as the subject is of particular interest at the present time.

EXPLOSION.—When gas or vapour is released so suddenly as to cause a loud noise an explosion is said to occur, as, for instance, the explosion of a steam boiler or a cylinder of compressed gas. Great and increasing use is made of explosive processes in gas, petrol, and oil engines for driving machinery of all kinds. In these engines the material that explodes is a mixture of air with combustible gas, vapour, or finely-comminuted liquid, and in the explosion these are suddenly converted into water vapour and the oxides of carbon, which latter are gases. Although all these things are liable to explode, none of them are called explosives; this term is confined to liquid and solid substances, which produce much more violent effects than exploding gaseous mixtures, because they occupy much smaller volumes originally.

EXPLOSIVE.—An explosive is a solid or liquid substance or mixture of substances which is liable, on the application of heat or a blow to a small portion of the mass, to be converted in a very short interval of time into other more stable substances largely or entirely gaseous. A considerable amount of heat is also invariably evolved, and consequently there is a flame.

GAS EVOLUTION.—That evolution of gas (or vapour) is essential in an explosion is rendered evident by considering thermit. This consists of a mixture of a metallic oxide, generally oxide of iron, with aluminium powder. When suitably ignited the aluminium is converted into oxide and the iron or other metal is set free in a very short interval of time with the evolution of an enormous quantity of heat, but there is no explosion. It is indeed because no gas is evolved that thermit can be used, as it is, for local heating and welding.

HEAT LIBERATION.—It is also an essential condition that heat should be evolved in an explosive reaction, otherwise the absorption of energy due to the work done by the explosion would cool the explosive and consequently slow down the reaction until it ceased, unless heat were supplied from without. Ammonium carbonate, for instance, readily decomposes into carbon dioxide, ammonia, and water, but in so doing it absorbs heat; consequently the reaction is much too slow to be explosive. Ammonium nitrate, on the other hand, is decomposed into oxygen, nitrogen, and water, with the evolution of heat, and is consequently liable to explode. A violent impulse is required to start the explosion, but once it is started the energy (or heat) liberated suffices to propagate the explosion, unless the conditions be such that the energy is dissipated more rapidly than it is liberated.

SENSITIVENESS.—Another essential for an explosive is that the reaction shall not set in until an impulse is applied. If the reaction set in spontaneously, it is obvious that its energy cannot be utilised in the form of an explosion. A mixture of sodium and water evolves hydrogen with the liberation of heat, but reaction sets in immediately the two substances come in contact with one another. Different explosives require impulses of very different strengths to cause them to explode. Some, such as diazobenzene nitrate, are exploded by a slight touch; these explosives are of no practical utility as they are too unsafe. Others, such as fulminate of mercury, are exploded by a moderate blow or a small flame; these are used principally for charging caps and detonators, a small quantity serving to explode a large amount of some other less sensitive explosive. Most of the explosives now used can be exploded by a blow only if it be extremely violent, and many of them cannot be exploded by a flame in the open in ordinary circumstances. The tendency is to use less sensitive explosives because they are safer to handle, but it should never be forgotten that the term "safe," when applied to an explosive, is only a comparative one. The duty of an explosive is to explode, and if it is not treated with proper respect it will, sooner or later, explode at the wrong time with extremely unpleasant results.

Before the subject of explosives was understood so well as it is now, inventors were very liable to think an explosive was very powerful, and therefore valuable merely because it was very sensitive, whereas too great a degree of sensitiveness is really a most objectionable feature. In the middle of the nineteenth century many such mixtures as potassium chlorate and picric acid were proposed through this want of comprehension of a fundamental condition.

CONSTITUENTS OF EXPLOSIVES.—The explosive gaseous mixtures used in gas and oil engines to which reference has been made are composed of a combustible material, consisting largely of carbon and hydrogen, and air, the useful constituent of which is oxygen. Similarly, nearly all commercial explosives are composed partly of combustible elements, of which carbon and hydrogen are the most important, and partly of oxygen combined, but not directly with the hydrogen and carbon. On explosion the oxygen combines with the hydrogen to form water, and with the carbon to form carbon monoxide or dioxide, or a mixture of the two. It is the heat set free in this combustion that is the main or entire cause of the rise of temperature. The formation of these two oxides of carbon liberates very different quantities of heat; 12 grams of carbon

unite with 16 grams of oxygen to form 28 grams of carbon monoxide with the liberation of 29 large Calories, and the same quantity of carbon unites with 32 grams of oxygen with the liberation of 97 large Calories.

Consequently an explosive is considerably more efficient if it contains sufficient oxygen to oxidise the carbon entirely to dioxide, but the effect is reduced to some extent by the relatively high specific heat of carbon dioxide. In some classes of explosives, however, a very high temperature is objectionable; this is the case with smokeless powders and explosives for use in coal mines. Smokeless powders, therefore, are generally made of such a composition that the greater part of the carbon is oxidised only to monoxide. But there is always some carbon dioxide formed, for it takes up some of the oxygen from the water vapour and liberates hydrogen, or if the total quantity of oxygen be very small there may even be free carbon produced. In the case of safety explosives for coal mines, the temperature of explosion is also sometimes kept low by restricting the proportion of oxygen, but this means is not free from objection because carbon monoxide is poisonous. Other methods are therefore adopted in some safety explosives to reduce the temperature.

OXYGEN CARRIERS.—The oxygen may either be contained in a separate compound, such as saltpetre, which is mixed mechanically with the combustible material, or the two may be combined together in a single compound, as is the case with nitroglycerine, trotyl, and many other modern explosives. The substances rich in oxygen are often referred to as "oxygen carriers"; those most used are nitrates, chlorates, and perchlorates, in which the oxygen is united to nitrogen and chlorine respectively. Ordinary gunpowder, or "black powder," belongs to the class of explosives that have separate oxygen carriers, in this case saltpetre. The following table shows the properties of the principal oxygen carriers:—

pose them than the nitrates, and have more available oxygen. As they are now produced at quite low cost by electrolytic methods, it is not surprising to find that they are being used more and more for the manufacture of explosives. Ammonium nitrate and perchlorate decompose with the evolution of heat, this being due to the formation of water, but the available oxygen is diminished by the same cause. Ammonium nitrate can be detonated by itself, although only with difficulty, and then gives a large volume of gas at a comparatively low temperature. In consequence of this low temperature it has been found very useful as a constituent of safety explosives for use in coal mines, but it also forms part of many other high explosives. Ammonium perchlorate suffers under the disadvantage that amongst its products of explosion is the poisonous gas, hydrogen chloride, or hydrochloric acid.

Potassium permanganate and bichromate have also been used, but they possess no special advantages. Permanganate explosives are often inconveniently sensitive. Attempts have also been made to use liquid oxygen, which has the advantage of being cheap and containing 100 per cent. of available oxygen, but the difficulties of employing a liquid which boils at 200° C. below the ordinary temperature are so great that these attempts were given up. The Germans are, however, making great efforts to develop these explosives for work in mines, so as to set free a corresponding quantity of nitrates for military use. For the same reason the German authorities are encouraging the use of chlorates and perchlorates.

COMBUSTIBLE CONSTITUENTS.—In black powder the combustibles are charcoal and sulphur; in blasting explosives many sorts of organic matter have been used or proposed, and some inorganic substances, such as potassium ferrocyanide, ammonium oxalate, and antimony sulphide, but those in common use are not very numerous. For explosives containing nitroglycerin an absorbent material must be used, and of

Oxygen carrier	Molecular weight	Density	Reaction	Heat evolved		Oxygen available	
				per mol.	per 100 grams.	per 100 grams.	per 100 c.c.
Nitrates.							
Potassium	101·1	2·08	$2KNO_3 = K_2O + N_2 + 5O$	−75·6	−74·8	39·5	82
Sodium	85·0	2·26	$2NaNO_3 = Na_2O + N_2 + 5O$	−60·5	−71·3	47	106
Calcium	164·1	2·36	$Ca(NO_3)_2 = CaO + N_2 + 5O$	−70·6	−43·0	49	115
Barium	261·5	3·2	$Ba(NO_3)_2 = BaO + N_2 + 5O$	−94·4	−36·1	31	98
Lead	331·1	4·58	$Pb(NO_3)_2 = PbO + N_2 + 5O$	−54·6	−16·5	24	111
Ammonium	80·1	1·71	$NH_4NO_3 = 2H_2O + N_2 + O$	+27·6	+34·5	20	34
Chlorates.							
Potassium	122·6	2·00	$KClO_3 = KCl + 3O$	+11·9	+ 9·7	39	78
Sodium	106·5	2·29	$NaClO_3 = NaCl + 3O$	+13·1	+12·3	45	103
Barium	304·3	3·18	$Ba(ClO_3) = BaCl_2 + 6O$	+25·9	+ 8·5	31·5	100
Perchlorates.							
Potassium	138·6	2·54	$KClO_4 = KCl + 4O$	− 7·8	− 5·6	46	117
Sodium	122·5	—	$NaClO_4 = NaCl + 4O$	−12·4	−10·2	52	—
Barium	336·3	—	$Ba(ClO_4)_2 = BaCl_2 + 6O$	− 4·3	− 1·3	38	—
Ammonium	117·5	1·89	$2NH_4ClO_4 = 2HCl + 3H_2O + 5O$	+29·5	+25·1	34	65

It will be seen that the proportion of available oxygen is about the same in the chlorates as in the corresponding nitrates, but whereas the chlorates decompose with the evolution of a small amount of heat, the nitrates require a considerable amount of heat to split them up, except in the case of the ammonium compound. Explosives containing chlorates are consequently much more powerful than those containing nitrates, but they are also very sensitive unless special measures are adopted to render them more inert. The perchlorates require considerably less heat to decom-

these wood meal is the most usual, but flour and starch are constituents of some nitroglycerin explosives, and in a few cases such substances as tan meal and prepared horse-dung are present. Cork charcoal has great absorptive power, but its high cost prevents its use. Ordinary charcoal is a constituent of some explosives, as also is coal-dust. American dynamites often contain resin and sulphur, and these constituents are sometimes met with in other explosives. Oily materials, such as castor oil, vaselin, and paraffin wax, reduce the sensitiveness of an explosive, and one or

other of them may usually be found in a chlorate blasting explosive. The addition of aluminium greatly increases the heat of explosion; it is present in the explosives of the ammonal type.

NITRO-AROMATIC COMPOUNDS.—Modern high explosives very frequently contain nitro-derivatives of the aromatic compounds obtained from coal tar, especially the mono- di- and tri-nitro-derivatives of benzene, toluene, and naphthalene. The nitro-groups in these compounds contribute oxygen for the explosive reaction. The trinitro-compounds of substances containing only one benzene ring are explosives in themselves; trinitrotoluene, for instance. Trinitrotoluene is not only a constituent of composite explosives, but is also very largely used by itself as a charge for shell and submarine mines, and for other military and naval purposes, for which its insensitiveness combined with its great violence render it suitable. Picric acid (trinitrophenol) is also much used for these purposes, and trinitrocresol to a less extent. Although they detonate with great violence, these trinitro-compounds do not contain sufficient oxygen to oxidise the whole of the carbon they contain even to the stage of carbon monoxide. Their power as explosives is, therefore, increased by mixing them with oxygen carriers. Commercial explosives containing trinitrotoluene always have also some other constituent which can supply the deficient oxygen.

NITRIC ESTERS.—Nitroglycerin and the nitrocelluloses are the principal members of another very important group of substances that can be used as explosives without admixture. Strictly speaking, they are not nitro-derivatives, but nitric esters. The more highly nitrated celluloses, such as guncotton, contain enough oxygen to convert all the hydrogen into water and the carbon into monoxide, and even some of it into dioxide. Nitroglycerin, $C_3H_5N_3O_9$, not only has enough to oxidise entirely all its hydrogen and carbon, but also has a little oxygen left over. Nitroglycerin is the most powerful explosive compound known, but its power is increased by dissolving in it a small proportion of nitrocellulose, which utilises the excess of oxygen and at the same time converts it into a gelatinous solid known as blasting gelatin.

SMOKELESS POWDERS.—All smokeless powders consist largely of nitrocellulose, which has been more or less gelatinised and converted into a compact colloid by means of a suitable solvent; many of them contain practically nothing else, but in others there is a considerable proportion of nitroglycerin. Small percentages of mineral jelly, inorganic nitrates, and other substances are also added, in many cases to improve the ballistics or the stability. Powders for rifled arms are always colloided as completely as possible, whether they be for small-arms or ordnance, to make them burn slowly and regularly, but in shot-gun powders the original structure of the nitrocellulose is not always destroyed entirely, as they are required to burn comparatively rapidly.

ENDOTHERMIC COMPOUNDS.—There are some explosive compounds which do not depend at all for their action on oxidation or reduction. These are endothermic substances, which decompose with the evolution of gas and heat; they are usually rather sensitive. The only compounds of this class that are of commercial importance are fulminate of mercury, $Hg(CNO)_2$, and lead azide, PbN_6, both of which are used only for exploding other explosives.

VELOCITY OF EXPLOSION.—The heat and gas evolved are the two principal factors which govern the power of an explosive, *i.e.* the amount of work it can do in the way of displacing objects. But the time taken by the explosion is also a matter of great importance. The rate of explosion is measured by making a column of the explosive, confining it, if necessary, in a metal tube, and measuring the time that the explosive wave takes to travel a known distance. In black powder and similar nitrate mixtures the velocity of explosion is only a few hundred metres a second, but with modern high explosives the velocity of detonation is from two to seven thousand metres a second. This naturally makes them much more violent and destructive. Explosives of the gunpowder type are used when earth or soft rock is to be blasted, or when the material must not be broken up too much. Propellants for use in firearms are required to burn slowly; for rifled arms they must be slower even than gunpowder. They are not exploded by means of another high explosive, but merely lit by a powerful flame, and should then burn by concentric layers. The rate of burning increases with the pressure in the gun, but for completely gelatinised powders it is less than a metre a second.

A. MARSHALL.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Scottish Association for the Medical Education of Women has placed with the authorities of the University of Edinburgh the sum of 237*l.* for the purpose of founding a prize for women medical students.

THE Foulis memorial scholarship of the University of Glasgow has been awarded to Dr. John Cruickshank, pathologist to the Crichton Royal Institution, Dumfries, for distinction in original work in pathology.

IT is announced in the issue of *Science* for January 14 that four business men of Portland have contributed 5000*l.* toward the new buildings for the medical department of the University of Oregon, Portland. This makes available the 10,000*l.* appropriated by the State. The officers of the college now propose to raise an additional 20,000*l.*

THE issue of the *Pioneer Mail* for January 1 contains a report of the eleventh session of the Indian Industrial Conference, which commenced its sittings on December 24 last. It was the first time the conference had met in Bombay since its inception. There was an unusually large attendance of delegates and distinguished visitors. The president, Sir Dorabji J. Tata, is one of the pioneers of Indian industry. In the course of his address, he referred to the importance of industrial education, and said industrial education in the widest sense of the term is primarily the function of the State. But a good many people wish the State to go far beyond this *rôle* and to enter into the actual field of industrial enterprise. The president's message to the Congress, and through it to his countrymen, was "Educate, Organise, Co-operate." Scientific, technical, economic education is the function of the State, but he said they must take their share of the burden. If they really wanted higher scientific education and were determined to profit by it, they would get it. Dr. H. H. Mann, principal of the Agricultural College, moved a resolution earnestly recommending the establishment of a technological faculty at the principal Indian universities, the development of already existing technical institutions, the opening of new institutions, and the gradual introduction of technical instruction in primary and secondary schools. The resolution, which was adopted, appealed to men of capital and industry to help young Indians technically trained in finding practical work and employment.

THERE is a widespread opinion among competent authorities that an independent inquiry should be made into our system of education, particularly as regards its organisation, the powers of the Board of Education, the relations of the Board to local education

authorities, and even the qualifications of members of the Board assigned to special posts in connection with work of science and technology, subjects and methods of instruction, and the like. The matter was brought before the House of Commons on January 26 by Sir Philip Magnus, who asked the Prime Minister "whether he will consider the desirability of appointing a Committee of Members of the House of Commons, and of other persons interested in and having a practical knowledge of the subject, to inquire into the present organisation of education in this country, and to report as to whether, having regard to the experience gained in the operations of the war and to the new social and economic conditions that may result when the war is over, any and, if so, what changes it may be thought advisable to introduce into our national system of education, with a view to establishing, without unduly interfering with other aims, a closer connection between our commercial and industrial requirements and the teaching provided in our several educational institutions, and in order to secure such further development as may be found necessary of existing facilities for scientific research and the better training of all classes of the population for the activities in which they may be severally engaged?" Mr. Asquith's reply was somewhat evasive of the points raised; and the substance of it was that he did not think it would be desirable to set up the Committee suggested, and that the President of the Board of Education would be glad "to consult all persons or bodies who are in a position to give advice on this matter." As the functions and influence of the Board itself are among the main points requiring consideration, the reply cannot be regarded as very satisfactory, and we hope that Sir Philip Magnus will raise the matter again. The Board is now practically the supreme governing body, not only of almost every grade and class of school, but also of most of our university institutions; and in its hands lies the scheme for the development of scientific and industrial research. As we understand the question, one of the objects of the Committee would be to inquire whether the Board is promoting educational and other work adapted to modern conditions and national needs, and whether practical and scientific studies can receive adequate attention under its present constitution. There are many who think otherwise, and a Committee could determine whether the dissatisfaction is well founded or not.

A COMMITTEE of the Association of Public School Science Masters has drawn up a strong memorandum on the unsatisfactory position which science occupies in national affairs, and particularly in our public schools and the old universities. The memorandum is signed by many distinguished leaders of scientific work and thought, and communications with reference to it are invited by the committee; they should be addressed to the secretary, Reorganisation Committee, 107 Piccadilly, London, W. A few of the matters mentioned in the memorandum are here summarised: Not only are our highest Ministers of State ignorant of science, but the same defect runs through almost all the public departments of the Civil Service. It is nearly universal in the House of Commons, and is shared by the general public, including a large proportion of those engaged in industrial and commercial enterprise. An important exception to this rule is furnished by the Navy, and also by the medical service of the Army. Our success now, and in the difficult time of reorganisation after the war, depends largely on the possession by our leaders and administrators of scientific method and the scientific habit of mind. For more than fifty years efforts have been made by those who are convinced of the value of training in experimental science to obtain its introduction into the schools and colleges of the country as an essential part of the education given therein. At Cambridge only four colleges are presided over by men of scientific training; at Oxford not one. Of the thirty-five largest and best known public schools thirty-four have classical men as headmasters. Science holds no place in the list. Science has been introduced as an optional subject for the Civil Service examinations, but matters are so arranged that only one-fourth of the candidates offer themselves for examination in science. It does not pay them to do so; for in Latin and Greek alone (including ancient history) they can obtain 3200 marks, while for science the maximum is 2400, and to obtain this total a candidate must take four distinct branches of science. For entrance into Woolwich, science has within the last few years been made compulsory, but for Sandhurst it still remains optional. This college is probably the only military institution in Europe where science is not included in the curriculum. If a Bill were passed directing the Civil Service Commissioners and Army Examination Board to give a preponderating—or at least an equal—share of marks in the competitive examination to science subjects, with safeguards so as to make them tests of genuine scientific education and not an incentive to mere "cram," the object we have in view would be obtained. Eventually the Board of Trade would be replaced by a Ministry of Science, Commerce, and Industry, in full touch with the scientific knowledge of the moment. Public opinion would compel the inclusion of great scientific discoverers and inventors as a matter of course in the Privy Council, and their occupation in the service of the State. Our desire is to direct attention to this matter, not in the interests of existing professional men of science, but as a reform which is vital to the continued existence of this country as a Great Power.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 27.—Sir J. J. Thomson, president, in the chair.—Prof. J. **Joly**: A collision predictor. The collision predictor is a mathematical instrument of simple construction. It enables the mariner when navigating in fog or thick weather to foretell risk of collision with another ship, and also the moment at which the risk is greatest. The ships concerned are supposed to be aware of each other's course and speed, and (at intervals) of their distance apart. The determination of distance is made according to principles described in a previous communication to the Royal Society. The operation of taking a reading on the collision predictor takes less than half a minute. The construction of the instrument and the principles involved cannot be conveyed without diagrams.—Dr. C. **Chree**: Discussion of Kew magnetic data, especially the diurnal irregularities of horizontal force and vertical force, from ordinary days of the eleven years 1890 to 1900. The paper is mainly devoted to a discussion of the results of measurements of the horizontal force and vertical force curves from the magnetographs at Kew Observatory for the eleven years 1890 to 1900. Subsequent to 1900, artificial electric currents diminished the value of the curves. One of the main objects is the study of the diurnal variation as given by "ordinary" days, *i.e.* all days with the exception of the highly disturbed. The changes of the regular diurnal variation throughout the year are dealt with in detail, and the inequalities are expressed in Fourier series. An investigation is also made of the annual inequality. For this purpose use is made of results for years subsequent to 1900, as well as of those between 1890 and 1900. The relation

of the diurnal inequality to sun-spot frequency is considered in the light of Wolf's formula, the constants in the formula being determined by least squares. Considerable attention is also paid to the absolute daily range or difference between the extreme values for the day. The frequency of occurrence of ranges of different size is considered in detail.—G. W. **Walker**: A portable variometer for magnetic surveying. The paper contains an account of a portable magnetic variometer for measuring horizontal force in a magnetic survey. The results obtained with it and with a Kew unifilar at forty-eight stations in the course of the magnetic survey of the British Isles in 1915 are discussed. The operation of measuring force is reduced to a single reading of the instrument, with a reading of the temperature, at a definite instant of time, in place of the elaborate system of readings taking over an hour when a unifilar is used. It is estimated that the normal error is not likely to exceed 5γ.—Prof. J. C. **McLennan**: The single-line spectrum of magnesium and other metals, and their ionising potentials. It has been shown that magnesium vapour traversed by electrons can be stimulated to the emission of a single-line spectrum consisting of the wavelength $\lambda=2852 \cdot 22$ A.U. It has been shown that the absorption spectrum of non-luminous magnesium vapour contains an absorption band at $\lambda=2852 \cdot 22$ A.U., and one at $\lambda=2073 \cdot 36$ Å.U. As the lines $\lambda=2852 \cdot 22$ Å.U., and $\lambda=2073 \cdot 36$ Å.U., are respectively the first members of the series $\nu=2,p_2-1 \cdot 5$, S, and $\nu=1 \cdot 5$, $S-m$, P, respectively, the absorption spectrum of magnesium vapour has been shown to be analogous to the absorption spectra of the vapour of mercury, zinc, and cadmium. The ionising potentials have been deduced for atoms of magnesium, in addition to those for the atoms of mercury, zinc, and cadmium. Considerations have also been presented which show that if Bohr's theory affords an explanation of the origin of single-line spectra, then Frank and Hertz and also Newman must have placed a wrong interpretation on the results of their direct investigation of the ionising potentials for mercury atoms.—F. **Tinker**: The microscopic structure of semi-permeable membranes, and the part played by surface forces in osmosis. Microphotographs of the common precipitation membranes, taken by a new method, show that such membranes are composed of small precipitate particles packed closely together, and ranging from $0 \cdot 1\ \mu$ to $1 \cdot 0\ \mu$ in diameter. Each of these precipitate particles is, however, not simple in structure, but is itself an aggregate formed by the flocculation of smaller ultra-microscopic particles. Of the membranes examined, copper ferrocyanide and Prussian-blue have the smallest particles. Precipitation membranes show most of the physical properties of gels as ordinarily prepared by bulk precipitation, but they have not the same mechanical structure as the latter, the membrane having a much finer texture than the gel proper. The pores in a copper ferrocyanide membrane range from 8 $\mu\mu$ to 60 $\mu\mu$ in diameter. Their size is such that they can block colloidal molecules mechanically, but not the ordinary crystalloidal molecules even when highly hydrated. The order of a series of membranes with respect to pore size is the same as that of their efficiency as semi-permeable membranes. Copper ferrocyanide and Prussian-blue are the most efficient membranes, and they have also the smallest pores. There is a very close connection between the osmotic properties of a membrane and the extent to which the membrane capillaries are under the control of surface forces. Osmotic effects are probably the result of adsorption phenomena occurring at the surface of the membrane and in the capillaries, the membrane being relatively impermeable to solutes negatively adsorbed, but permeable to solutes positively adsorbed.—E. **Newbery** and J. N. **Pring**: The reduction of metallic oxides with hydrogen at high pressures. Metallic oxides have been heated to temperatures of 2500° C. in dry hydrogen at pressures up to 150 atmospheres, water vapour being removed by metallic sodium. The following oxides were reduced to metals:—

Cr_2O_3 to Cr. MnO_2 to Mn.

The following oxides were reduced to lower oxides:—

V_2O_5 to VO TiO_2 to TiO.
Nb_2O_5 to NbO. CeO_2 to Ce_2O_3.
U_3O_8 to UO_2.

The following oxides were unchanged:—

Al_2O_3, MgO, ZrO_2, Y_2O_3, ThO_2.

The metals obtained, chromium and manganese, are probably the purest samples of these metals that have been prepared up to the present. This supposition is supported by the sharp nature of their melting points, a feature which has not been observed with samples prepared by other methods.—H. **Levy**: Discontinuous fluid motion past a curved boundary. The author considers the regions in the $w(=\phi+i\psi)$ and $\Omega(=\log dz/dw)$ planes, corresponding to the problem of the discontinuous motion of a fluid in two dimensions past a curved boundary, and shows that the problem will be solved if the formulæ can be found to transform these regions conformally into the same region in a t-plane. This the author succeeds in accomplishing by a synthetic method he has devised—the vectorial superposition of rectangles in the Ω-plane. By this means it is demonstrated that the problem of the impact of a fluid against a boundary, differing by as little as may be desired from a given boundary, may be easily solved. The author pursues in full detail the case of symmetrical surfaces and of plane surfaces with curved ends. A few particular cases are worked out completely.

Royal Meteorological Society, January 19.—Major H. G. Lyons, president, in the chair.—Major H. G. **Lyons**: Winter climate of the eastern Mediterranean. During the last fifteen to twenty years a large number of meteorological stations have been in operation, and from their published results we have an accurate and detailed knowledge of the meteorological conditions which prevail there at the different seasons of the year. These vary from the true continental climate of the Balkans, with its low winter temperatures and moderate rainfall at all seasons, to the Mediterranean climate of southern Greece and the Levant, with its mild winter, hot summer, and a strongly marked rainy season in winter. In lower Egypt these characteristics also prevail in a more intense form. The geographical character of the Balkan Peninsula and the surrounding seas, Syria and Palestine, and lower Egypt, affect to some extent the general climatic conditions. The temperature in the Balkan region in winter is frequently very low, descending to 0° F., and often below this at many stations, while frost occurs often at inland Greece, and occasionally throughout the eastern Mediterranean. January is the coldest month, and February differs but little from it, the first marked departure from winter conditions occurring in March. By this month, too, the waters of the Mediterranean begin to grow warmer. In winter rainfall is heaviest on the western shores of Greece and Syria, and markedly less on the eastern coasts. The Balkan rainfall has a maximum in November and afterwards decreases slightly, but it is not heavy at any time. Rainfall decreases southward, and in lower Egypt the amount is insignificant. Northerly winds which cause rough sea in the Ægean Sea during the winter months are more frequent than southerly winds in the proportion of 2·5 to 1.

Challenger Society, January 26.—Prof. E. W. McBride in the chair.—C. Tate **Regan**: Larval fishes from the Antarctic. The development of *Myctophum antarcticum* was contrasted with that of the northern *M. glaciale*, and larval and post-larval stages of species of Nototheniidæ and related families were described.

BOOKS RECEIVED.

A History of the Family as a Social and Educational Institution. By Prof. W. Goodsell. Pp. xiv+588. (New York: The Macmillan Company; London: Macmillan and Co., Ltd.) 8*s*. 6*d*. net.

Anuario del Observatorio de Madrid para 1916. Pp. 645. (Madrid: Bailly-Balliere.)

Transactions of the Royal Society of Edinburgh. Vol. li. Part 1 (No. 4). The Temperatures, Specific Gravities, and Salinities of the Weddell Sea and of the North and South Atlantic Ocean. By Dr. W. S. Bruce, A. King, and D. W. Wilton. Pp. 169. (Edinburgh: R. Grant and Son; London: Williams and Norgate.) 8*s*. 3*d*.

Proceedings of the Royal Society of Edinburgh. Session 1914–15. Part iii., vol. xxxv. Pp. 225–402. (Edinburgh: R. Grant and Son; London: Williams and Norgate.)

East Lothian. By T. S. Muir. Pp. viii+117. (Cambridge: At the University Press.) 1*s*. 6*d*. net.

The Observer's Handbook for 1916. Pp. 76. (Toronto: Royal Astronomical Society of Canada.)

Termodynamik. By P. B. Freuchen. Pp. 144. (Kobenhavn: Lehmann and Stages Forlag.)

Calendario del Santuario di Pompei Basilica Pontificia del SS. Rosario in Valle de Pompei, 1916. (Valle di Pompei.)

Senescence and Rejuvenescence. By C. M. Child. Pp. xi+481. (Chicago: University of Chicago Press: London: Cambridge University Press.) 4 dollars net.

Chemical Constitution and Physiological Action. By Prof. L. Spiegel. Translated, with additions, by Dr. C. Luedeking and A. C. Boylston. Pp. v+155. (London: Constable and Co., Ltd.) 5*s*. net.

Forging of Iron and Steel. By W. A. Richards. Pp. viii+219. (London: Constable and Co., Ltd.) 6*s*. 6*d*. net.

The Carnegie Trust for the Universities of Scotland. Fourteenth Annual Report (for the year 1914–15). Pp. 81. (Edinburgh: T. and A. Constable.)

Annuaire Astronomique et Météorologique, 1916. By C. Flammarion. Pp. 431. (Paris: E. Flammarion.)

Flora of the Presidency of Madras. By J. S. Gamble. Part 1. Pp. 200. (London: West, Newman and Co., and Adlard and Son.) 8*s*.

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 3.

ROYAL SOCIETY, at 4.30.—Note on an Orderly Dissimilarity in Inheritance from Different Parts of a Plant: Prof. W. Bateson and C. Pellew.—Observations on Coprozoic Flagellates, together with a Suggestion as to the Significance of the Kinetonucleus in the Pinucleata: H. M. Woodcock.—Investigations dealing with the Phenomena of Clot Formations. III. Further Investigations of the Cholate Gel: S. B. Schryver.—The Mechanism of Chemical Temperature Regulation: J. M. O'Connor.

ROYAL INSTITUTION, at 3.—Industrial Applications of Gaseous Fuels derived from Coal: Prof. W. A. Bone.

FRIDAY, FEBRUARY 4.

ROYAL INSTITUTION, at 5.30.—Fifteen Years of Mendelism: Prof. W. Bateson.

GEOLOGISTS' ASSOCIATION, at 8.—Presidential Address: The Geological History of Flying Invertebrates: G. W. Young.

MONDAY, FEBRUARY 7.

SOCIETY OF ENGINEERS, at 5.30.—Presidential Address: P. Griffith.

ARISTOTELIAN SOCIETY, at 8.—The Relation between the Theoretic and Practical Activities, with some reference to the views of Croce: Miss Hilda D. Oakeley.

SOCIETY OF CHEMICAL INDUSTRY, at 8.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Communications in the Balkans: H. C. Woods.

ROYAL SOCIETY OF ARTS, at 4.30.—National and Historic Buildings in the War Zone: Rev. Dr. G. H. West.

TUESDAY, FEBRUARY 8.

ROYAL INSTITUTION, at 3.—Nerve Tone and Posture: Prof. C. S. Sherrington.

ZOOLOGICAL SOCIETY, at 5.30.—A Collection of Moths made in Somaliland by Mr. W. Feather, with descriptions of new species by Sir G. F. Hampson and others: Prof. E. B. Poulton.—Report on the Deaths which occurred in the Zoological Gardens during 1915, together with a list of the Blood-parasites found during the year: Prof. H. G. Plimmer.

INSTITUTION OF CIVIL ENGINEERS, at 5.30.—Notes on the working of a Rack Railway: W. T. Lucy.

WEDNESDAY, FEBRUARY 9.

ROYAL SOCIETY OF ARTS, at 4.30.—The Organisation of Scientific Research: Prof. J. A. Fleming.

THURSDAY, FEBRUARY 10.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: The Theory of the Helmholtz Resonator: Lord Rayleigh.—The Oxyhydrogen Flame Spectrum of Iron: Sir N. Lockyer and H. E. Goodson.—The Consumption of Carbon in the Electric Arc. II. The Anode Loss: W. G. Duffield and M. D. Waller.—Surface Friction. Experiments with Steam and Water in Pipes: C. H. Lander.—The Structure of broadened Spectrum Lines: T. R. Merton.

ROYAL INSTITUTION, at 3.—Measurement of the Brightness of Stars; Visual and Photographic Magnitudes: Sir F. W. Dyson.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Testing of Underground Cables with Continuous Current: O. L. Record.

OPTICAL SOCIETY, at 8.—Optical or Visual Signalling: Dr. W. J. Ettles.

FRIDAY, FEBRUARY 11.

ROYAL INSTITUTION, at 5.30.—Egyptian Jewelry: Prof. W. M. Flinders Petrie.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Annual General Meeting.

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THURSDAY, FEBRUARY 10, 1916.

DEFECTS AND REMEDIES.

WHEN, thirteen years ago, Sir Norman Lockyer delivered before the British Association his address on "The Influence of Brain Power on History," it is not too much to say that his statement of the need for the promotion of intimate relations between statecraft, industry, science, and education fell mostly on inattentive ears. The lessons in modern history taught by that address were unmistakable, and the statement of consequences of continued neglect of scientific factors of national progress was prophetic, yet little heed was given to these subjects until the outbreak of hostilities revealed the weakness of our industrial position in comparison with the powerful and highly-organised forces fighting against us. War has caused an awakening which the pleasant times of peace failed to bring about; and our newspapers and magazines—general and technical, trading and scientific—are now giving attention to the subject and are publishing articles by men of science, manufacturers, and others on the provision to be made to ensure that close co-operation between scientific research and industrial development which is essential to the advance of a civilised community.

The points which are being discussed, and the views expressed, have been familiar to most men of science for many years; and Prof. E. B. Poulton was good enough to say in his recent Romanes lecture: "It would not be right to speak on the national neglect of science without acknowledging with gratitude the patriotic position taken for many years by the journal NATURE. If only the warnings given again and again in its pages had been heeded, I am confident that long before this time Germany's complete defeat and the freedom of the world would have been achieved."

We have waited a long time for public enlightenment as to the relation of science to national affairs, knowing that while consideration of the subject was confined to scientific circles, it would remain outside the realm of practical politics, where measures and administrative action are not determined by foresight so much as by expediency. Now that the war has shown the truth of the predictions of our scientific Cassandras, there is more reason to believe that action will be taken to avert the consequences of neglect in the past and to provide the conditions of advance in the future.

A letter signed by a number of distinguished men of science, published in the daily papers a few days ago, and referred to in our issue of February 3 (p. 640), directed attention to some of the defects in our national organisation as regards what may be termed scientific equipment. Though science enters into every part of modern life, and scientific method is necessary for success in all undertakings, the affairs of the country are in the hands of legislators who not only have little or no acquaintance with the fundamental facts and principles signified by these aspects of knowledge, but also do not understand how such matters can be best used to strengthen and develop the State. Our administrative officials are also mostly under the same disabilities, on account of their want of scientific training. They and army officers are educated at schools where science can receive little encouragement: "Of the thirty-five largest and best-known public schools thirty-four have classical men as headmasters"—they do not take up scientific subjects in the examinations for the Civil Service, because marks can be much more easily gained by attention to Latin and Greek; they need not take science for entrance into the Royal Military College, Sandhurst, which is "probably the only military institution in Europe where science is not included in the curriculum"; and the result of it all is that science is usually regarded with indifference, often with contempt, and rarely with intelligent appreciation by the statesmen and members of the public services whose decisions and acts largely determine the country's welfare.

The defects of a system that places the chief power of an organisation which needs understanding of science in every department, in the hands of people who have not received any training in scientific subjects or methods, are obvious. Some remedies are suggested in the recent statement to which we have referred; and the signatories anticipate the time when the Board of Trade will be replaced by a Ministry of Science, Commerce, and Industry, while leading scientific men and inventors are admitted to the Privy Council, and are given influential positions in the State service.

We are in complete sympathy with the views to which the men of science who signed the statement have given their support; indeed, all the points to which public attention has now been directed have on many occasions been dealt with in these columns. The British Science Guild was founded to urge all responsible authorities to give science its rightful place in national affairs, and it has persistently put forward these claims for

the past ten years or so. It is not a scientific society, or a Chamber of Commerce, or an educational association, but a national organisation in which the activities of all these bodies are united by the common bonds of scientific efficiency for the good of the State. While, therefore, the publication of the letter on the neglect of science is opportune and welcome, it seems unnecessary to form a "Reorganisation Committee," to which communications are to be addressed. The executive and other committees of the British Science Guild include leading representatives of all departments of pure and applied science, of many branches of commerce and industry, and of educational work from the primary school to the university. It is not unreasonable to suggest, therefore, that the new and anonymous Reorganisation Committee, which has secured the signatures to the recent statement, should exert its activities through the British Science Guild, instead of acting independently of the guild, and thus presenting a divided front to the forces to be overcome.

It is satisfactory to note that the White Paper [Cd. 8181] on British trade after the war, published last week, refers to the valuable work done by the guild with the object of promoting the manufacture of laboratory glassware in the country. Shortly after the outbreak of the war, the Technical Optics Committee took up the question of the supply of optical glass and instruments, and a committee was formed with the Association of Public School Science Masters to deal with the matter of laboratory glass. This committee found that glass manufacturers were disinclined to invest in new plant without some security against foreign competition after the war, but the difficulty was overcome by the guild sending a circular to more than a thousand schools and education authorities asking if they were prepared to undertake to use British-made glass during the war and for a period of three years after, provided that the prices were not prohibitive. The list of hundreds of schools and authorities which have given this general undertaking is published in the journal of the guild, just issued, and it should be of the greatest service to British manufacturers of laboratory glass. The same committee of the guild has rendered like valuable assistance by specifying the chief sizes and shapes of glassware required for laboratory purposes. These reports, and the enterprise of the Institute of Chemistry in determining and publishing formulæ for the manufacture of glasses of many kinds hitherto obtained mostly from abroad, have done more to give practical and scientific support to British glass manufacturers than any Government Department has accomplished since the outbreak of hostilities.

We give elsewhere the main points and recommendations of the recent White Paper, in so far as they relate to scientific matters. It is encouraging to find that the influence of scientific research upon industry, and the need for the State to make adequate provision for its promotion, are generously acknowledged. The nation has been ill-prepared against industrial expansion in the modern sense, and therefore it has found itself in an inferior position in times of war. The British manufacturer is now called upon to become an industrialist, and to co-operate with the scientific investigator in the promotion of industry as a whole. The British man of science must similarly cultivate a fuller interest in industrial applications, and appreciation of technical experience; and the change of attitude will act progressively both on science and industry. Finally, science should speak with a collective authority, and demonstrate by the conduct of its own affairs that it is capable of organised action and clear leading. We want to preserve the practical character of the British nation and yet to develop it to meet modern needs. That there can be successful organisation in manufacture is shown by the Ministry of Munitions; that the people can organise is proved by the position of the Trade Unions; that they can co-operate is evident from the success of the Co-operative Wholesale Society. It remains to develop still further the great principles—to organise and co-operate—among artisans, manufacturers, and scientific workers in order that our national capacities may be employed for the utmost good.

PSYCHOLOGY.

The New Psychiatry: being the Morrison Lectures delivered at the Royal College of Physicians of Edinburgh in March, 1915. By Dr. W. H. B. Stoddart. Pp. iv+66. (London: Baillière Tindall, and Cox, 1915.) Price 2s. 6d. net.

IT is the accepted duty of this journal to recognise all interests in natural knowledge, and as problems of the mind are included in this group we may fittingly and appropriately refer to the above volume. Mental problems are not easy to solve, and the old methods of observation and induction—hitherto called psychological analysis—have of late given way to what has been described

as "psycho-analysis," the assumed utility of the latter claiming for it a fresh title under the name of the "new psychiatry." Its author is Sigmund Freud, of Vienna, and one of its most brilliant exponents is K. Yung, of Zurich, who has lately tended to break away completely from the teachings and practice of the so-called "Freudian school." This school has few disciples among thoughtful and reflective men and women. In this country healthier conditions and a more natural and ethical view of life maintain, and we recognise that man is not an animal dominated by crude instinct and base passion, as the disciples of Freud maintain, but that he is a responsible being, fashioned after the image of God, and endowed with mental, spiritual, and physical attainments which can be proved by an experience not that of men of science only.

The causes, attributed by those whose lives are spent in the investigation of nervous and mental disorders to these pathological conditions, are observed chiefly in heredity, environment, education, fatigue, and various intoxications, whether these are generated within the body or introduced into it from without, the latter, for instance, being the poisons of alcohol, syphilis, tuberculosis, etc.; but the disturbing effects of strong emotion, grief, anxiety, and worry caused by any one specific event, such as a moral emotion, are also not excluded. Charcot, Hack Tuke, Savage, Janet, and many others have connected mental and nervous disorders with vivid emotional experiences, as also with the memories of these and with the conserved and revived ideas of such memories. It has been recognised that these memories may remain in the subconscious field, although capable of rising into the conscious mind under certain normal and abnormal conditions. It is the claim of the disciples of Freud that they can by "psycho-analysis" disclose the workings of this unconscious mind through the examination of spontaneously uttered thoughts, *i.e.*, "free-association," and that all conscious thought and action are coloured and influenced by the unconscious ones, which, indeed, are looked upon as the springs of action of all conscious ideas, which implies that the unconscious mind is the primitive soil out of which all conscious thoughts originate, and out of which all intellectual processes grow. Freud considers the conscious active mind of thought, feeling, and will to be a commingling of the unconscious and the conscious, in which the lower level supplies the motive force, whilst the upper regulates it. Thus there are many mental states which may be packed together in the mind at one time, though one or more of them may be repressed; as Bergson states, they may be compressed like steam in a boiler, so they may not rise to the conscious level of expression.

It is within the knowledge of every practising physician that certain sensations or experiences are able to determine certain attitudes of mind which may appear after their memories have faded, and the hypothesis that the memories of past experiences are potential agencies in determining certain abnormal mental symptoms is also an acknowledged fact. The teachings of Freud have certainly tended to elucidate many facts in the unconscious field. He maintains, for instance, that in the education of children many incidents are remembered, although more are forgotten; yet they remain engraved upon the marble of the unconscious mind. He cites the trend of social and ethical education to be mainly in the direction of repressing natural tendencies, suppressing feelings and passions, personal wishes and sentiments, which is thus a constant effort for the learning pupil, but which it succeeds eventually in more or less completely controlling. These tendencies, so repressed, may at any time become uppermost, and then give rise to wishes, longings, delusions, unfulfilled desires, dreams, or obsessions.

Dr. Stoddart's lectures are an eloquent brief for this Freudian school, and if his advocacy had ended here we should have been satisfied, interested, and gratified; but he carries his support to the extreme limit of Freudian disgust, and some parts of the lectures are unwarrantable, painful, and unjustifiable. Freud and Dr. Stoddart both believe that there is an unwillingness to recall or evoke painful feelings, that these are kept under by an assumed ego, the "endo-psychic censor," or, more briefiy, the "Censor"—a purely artificial inhibiting factor. Lapses of memory, which cause us not to do things we wish to do and intend to do, drop out of the mind owing to their lack of interest, and not owing to the working of an active and repressive force. It is claimed for Freudism that a solution is obtained to the problems of grammar, language, literature, art, and religion, and this ambitious aspiration we should willingly have passed by; but because the purpose of psycho-analysis is to discover some unpleasantly painful or shameful event in the past history of the patient, because these are taken to be the root cause of most cases of mental perversion, and because sexual matters are placed as the bed-rock of most cases of insanity—a hypothesis which is not only unjustifiable and unproven, but is also an insult to the clean mind of an innocent sufferer—we are compelled to remonstrate. The method of psycho-analysis practised by this school of the "new psychiatry" has been responsible for suggesting lewd, objectionable, and

bestial thoughts to a pure mind, and such practices should be repressed with all the strength of a controlling hierarchy—if such there be? It has been well said that "a diagnosis in the Freudian sense is a diagnosis of the mind that made it."

In Dr. Stoddart's lectures there is much that concerns the psychiatric specialist, as he is interested in all the attempted explanations of perversion, but there is little here for the scientific seeker after truth. The first chapter deals with fundamental psychical instincts; the second with the technique of psycho-analysis; and the last with its application. We are not in sympathy with much that is said by Freud's English exponent, and we assert from practical experience and a definite knowledge of the effect of psycho-analysis upon those among whom the craft is practised—in so far as it is a probing for hidden and forgotten sexual occurrences—that it is repulsive, disreputable, and ethically objectionable.

ROBERT ARMSTRONG-JONES.

THE ENERGY CHANGES IN VITAL PROCESSES.

Principles of General Physiology. By Prof. W. M. Bayliss. Pp. xx+850. (London: Longmans, Green and Co., 1915.) Price 21s. net.

WITHIN recent years many workers in the domain of physiology have made use of the more modern physical and chemical methods in their investigations, as is evident even from the most cursory study of present-day physiological and bio-chemical literature. Such a book, therefore, as that which Dr. Bayliss has just given us is of inestimable value to all who recognise that an approach to the study of physiology through the avenue of energetics is one that is bound to prove of great value. To deal satisfactorily with the principles of general physiology from this viewpoint requires, however, the expenditure of so much labour that at first sight it appears unlikely that one writer can take the whole burden upon his own shoulders. Dr. Bayliss has taken infinite pains in the preparation of a well-reasoned presentation of the physico-chemical laws which govern vital processes. Every page shows evidence of a critical study of the literature, much of which, at least until recently, lay outside the region of the physiologist. One of the great advantages which will result from a careful study of this book will undoubtedly be the direction of the attention of the reader to the physico-chemical literature of which the writer has made such good use.

The first chapter deals with certain of the properties of protoplasm, but naturally in a very brief form, as the subject is discussed from a variety of points of view in the subsequent chapters. The next seven chapters, along with chapter x., are in many respects the most valuable. They deal with such subjects as the laws of energetics, surface action, the colloidal state, permeability of membranes, osmotic pressure, the action of electrolytes, and catalysis and enzyme action. In the very interesting chapter on surface action, the properties of substances at their boundaries with other phases, for example, surface tension and electric charge, and their influence on solubility and chemical reaction, are dealt with before taking up the subject of adsorption. The parts played by mechanical surface energy and the electrical energy changes at a surface are carefully differentiated, and in the study of the combined effects of the two factors, the higher value of the latter is referred to. The changes subsequent to adsorption, removal from surface to interior or actual chemical combination, and the control of the rate of chemical combination by the preliminary adsorption process, are dealt with in a most interesting fashion. The section on the electrical charge on colloids and the part played by electrolytic dissociation on the same is, as one would expect, a most excellent one. That most important subject in colloidal chemistry, namely, the action of electrolytes on colloidal particles, receives due attention, the work of Hardy, Perrin, Burton, and Mines being specially referred to.

In dealing with the proteins from the physico-chemical point of view, it might have been advisable to give a rather more detailed account of amphoteric electrolytes in order to lead up to such subjects as the iso-electric point or zone and its relation to the denaturation or coagulation zone.

In the chapter on the permeability of membranes and the properties of the surface of cells, a very excellent account is given of our present knowledge, but the subject requires so much further work that the time has not yet come when a clear account of the various factors, physical and chemical, can be given. In the chapter on osmotic pressure, and also later on in the chapter on secretion, the writer refers to the influence which would be exercised by differences in permeability in various parts of the cell membrane; for example, the surface next the blood vessels compared to the surface next the lumen of the tube. A somewhat similar mechanism has been described by Lepeschin in certain organs of plants.

The chapter on electrolytes and their action is a most interesting one, but it would be advisable for the reader to supplement it by a study of a

text-book on physical chemistry dealing with the same subject. There is a slip in the equation of the dissociation constant in Ostwald's "Dilution Law" on p. 186.

Henderson's work on the maintenance of neutrality in the organism is very clearly described. In the carbonate phosphate equations given on p. 199 the proportion dissociated of NA_2HPO_4 in decimolar concentration is given as 0·04 instead of 0·64, as is evident from the proportions required to obtain a hydrion concentration of $1 \cdot 10^{-7}$. There are other slight numerical errata in this summary of Henderson's work.

We can only allude briefly to the remaining chapters, which are of a more purely physiological type. The essential characteristic of all is the originality of the treatment. Recent work in protein and carbohydrate metabolism receives due attention, but, as one would expect, the later chapters on catalysis and enzymes and on secretion receive much more elaborate treatment. The author very rightly directs attention to the necessity for very careful examination of all cases of supposed anti-ferment production. Undoubtedly in many cases the influence of alterations in hydrion concentration and adsorption have not been sufficiently considered in experiments on the production of antibodies.

The section dealing with excitation and inhibition will be read with the greatest interest and profit by all physiologists.

A slight alteration in the order of the closing chapters might have been advisable. The section on electrical changes in tissues receives an essentially modern treatment. It is somewhat pathetic that the older work in this, as in other departments of physiology, has been entirely displaced. There is no reference to the work of Du Bois-Reymond, just as in the subject of reflexes we find no reference to Pflüger's work. In the scope of this brief review we can refer only to the excellent articles on the action of light, on respiration, and on the action of hormones, drugs, and toxins.

The work as a whole requires careful study, and will undoubtedly serve as an incentive to research in many departments of physiology. It is written in a very pleasant style, and its value is enhanced by the interesting portraits of men of science whose work has contributed to the advance of physiology along the lines dealt with in this work. English physiology is indeed fortunate in numbering among its most able research workers one who has been able to enrich the science by this most valuable contribution to general physiology.

T. H. M.

A HANDBOOK FOR WIRELESS TELEGRAPHISTS.

Handbook of Technical Instruction for Wireless Telegraphists. By J. C. Hawkhead. Second edition, revised and enlarged. By H. M. Dowsett. Pp. xvi+310. (London: The Wireless Press, Ltd., 1915.) Price 3*s*. 6*d*. net.

THIS "Handbook of Technical Instruction for Wireless Telegraphists" would more suitably be entitled a "Handbook for the use of Marconi Operators in Wireless Telegraphy," because it deals almost exclusively with the methods and apparatus of the Marconi Company. It is divided into three parts: the first concerned with the elementary facts of electricity, the second comprising a couple of chapters on electromagnetic waves and receiving sets, and the third explaining the special appliances and systems of apparatus in use in the Marconi Company's installations.

Except for the fact that operators on board ship have not generally space in their cabins for many books, it is difficult to see why so much of this book should be occupied with the elementary information on electrical facts given in dozens of other manuals. In the first chapter the authors suggest that the term "difference of potential" is identical in meaning with the term "electromotive force." But this is not the case. We can have electromotive force created under conditions in which the term difference of potential has no meaning. Apart from one or two little defects in exposition, the information in part i. is useful so far as it goes, but would scarcely be sufficient for instruction taken alone, and would be unnecessary for operators who have already obtained a grounding in the elements of electrical knowledge elsewhere.

Part iii., which deals with the special apparatus of the Marconi Company, is, on the other hand, very useful, and is characterised by many excellent diagrams and photo illustrations of actual apparatus. The schemes of connection and internal arrangements of apparatus are particularly good and valuable, since the operator out of reach of land is thrown entirely on his own resources if anything goes wrong with his apparatus. The great experience of Marconi's Wireless Telegraph Company in land and ship installations has enabled them to perfect, in a very high degree, the details of all their apparatus so as to render it, so far as possible, absolutely certain in operation and highly efficient.

A very interesting chapter is that on the Marconi standard 1½-kilowatt wireless telegraph set, which is that mostly used on board ship, every detail of which has been the subject of the most

careful thought and invention on the part of the company's experts.

The concluding portion of this chapter deals in an especially interesting manner with the details of the receiving sets employing the Marconi magnetic detector, the crystal, and the Fleming oscillation-valve detectors. The balanced crystal and valve-detectors used for eliminating atmospheric disturbances are extremely well described. Chapter v. in part iii. is occupied with a description of the 5-kilowatt "battleship" set, which has particular interest at the present moment.

The following chapter is concerned with the portable and pack sets used in military work.

For a reader, even although not professionally a wireless telegraph operator, who has some general electrical knowledge, this practical part of the book will have considerable interest, and it can be strongly recommended as containing a concise, detailed account of the apparatus most used in the conduct of those wonderful feats of wireless telegraphy to which so many travellers by sea have owed escape from death. Altogether, the book is a useful addition to the library of the wireless telegraphist, and its excellent illustrations and good make-up are creditable to both authors and publishers. A very good feature is the intermingling of photo reproductions showing the actual appearance of the apparatus, with well-drawn schemes of connections showing the arrangement of the circuits.

OUR BOOKSHELF.

Manual of the New Zealand Mollusca. By H. Suter. Atlas of plates; 72 plates with descriptions. (Wellington, N.Z.: John Mackay, Government Printer, 1915.) n.p.

THE appearance of this volume of plates completes the publication of Mr. Suter's "Manual of New Zealand Mollusca." Nearly every species described in the text has been figured, thereby enhancing the value of the work as a book of reference. The illustrations reach a high level of excellence, and the figures generally are clear, well drawn, and adequate in detail. The least satisfactory are those on plates 2, 7, and 50, in which the details are so obscured that the figures are almost useless.

The weakest part of this volume is that devoted to Nudibranchs. Only fifteen out of thirty-seven species are illustrated, and only eight of these figures (plates 36 and 37) are sufficiently good to aid in the identification of species. These Mollusca must be studied alive, and the figures drawn and reproduced in colour to be of any service. The difficulties of obtaining such figures and the high cost of reproduction have doubtless precluded their use in this work. The explanations of the figures are accompanied by a note of the actual size, presumably of the specimen figured, and references to the text, details for which those who use the work will thank the author.

We renew our congratulations to Mr. Suter and the New Zealand Government on the publication of this volume of plates. The author has earned the thanks of conchologists the world over, and particularly of students of Mollusca in the Dominion, for undertaking the work and for the thoroughness and care with which it has been done.

W. M. T.

Morphology and Anthropology. A Handbook for Students. By Dr. W. L. H. Duckworth. Volume i. Second Edition. Pp. xiv + 304. (Cambridge: At the University Press, 1915.) Price 10*s.* 6*d.* net.

IN the eleven years which have elapsed since Dr. Duckworth's indispensable manual made its first appearance, there has been a rapid growth in all those branches of knowledge on which "Morphology and Anthropology" are based. This is especially the case as regards our knowledge of the anatomy of the Primates—particularly of the anthropoid apes. Hence in the present edition of his manual Dr. Duckworth has found it necessary to expand that section which deals with the anatomy of the Primates and with the position of the Primates in the mammalian phylum to such an extent that it now appears as a separate volume. In its present shape this volume gives an excellent introduction to a systematic study of the anatomy of man and of the animals which are closely related to man in structure and in origin. So far as we know, there is no other book in the English language which covers the same ground.

By turning over and comparing the pages of the present and past editions, particularly the illustrations, one is struck by the progress made during the past eleven years. During that time the cortical areas of the brain of man and every group of ape has been worked out; Dr. Duckworth has chosen excellent figures to represent this and other aspects of our progress. This volume is more of the nature of a new work than of a new edition, so much has it been rewritten, expanded, and in every way improved.

Heaton's Annual. The Commercial Handbook of Canada and Boards of Trade Register, 1916. Pp. 506. (Toronto: Heaton's Agency; London: Simpkin, Marshall, Hamilton, Kent and Co., Ltd.) Price 5*s.*

THE twelfth issue of this useful yearly work of reference contains, in addition to its usual contents, which have been described on previous occasions, a new section entitled "Where to find it." This part provides a guide to Dominion and Provincial Government reports and other standard publications showing those contents of interest to travellers, intending settlers, and others, and how the reports and books indexed may be procured. The volume may be commended especially to teachers of commercial geography who should find its mass of conveniently arranged information invaluable.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Latin as a Universal Language.

IN the notice of Prof. Guido Baccelli in NATURE of January 27, you mention that at the meeting of the eleventh International Congress of Medicine in Rome in 1894 he made a powerful appeal for the introduction of Latin as a universal language all over the world. This proposal seems to me so important and valuable that it should not be passed over with a simple reference, but should, on the contrary, receive the most careful consideration, not only from the councils of our universities, from the heads of schools, and from educational authorities in general, but from all business men and all lovers of their country.

It is generally conceded that the study of Latin is one of the best means of training a schoolboy's brain. But an objection which is daily gaining force is that Latin occupies far too much of a schoolboy's time, and it is given undue prominence in examinations to the exclusion of other subjects of more value. Except for its use as a subject of training, Latin, as at present taught in most schools, is only of use to a few scholars, and the majority of those who have spent several painful years in acquiring it at school find little or no use for it in after-life, and more or less completely forget it. But the case would be very different if Latin were generally taught, not as a dead, but as a living language; as, indeed, it is taught already in a few schools. Just as the boys in the Balearic Islands are said to have acquired their skill in using the sling by the necessity of bringing down their dinners by it from places out of their reach, so boys can learn very quickly to speak Latin correctly if they have to ask for their food at table and other things they want in that language.

As is said in your notice of Prof. Baccelli, a very slight alteration in the present curriculum would enable boys to speak Latin, but if it is to be a universal language a mode of pronunciation common to all countries must be employed. I am aware that the Board of Education has succeeded in introducing the reformed pronunciation in the secondary schools controlled by it, and that the rules of the Classical Association are now widely adopted; so that the foundations of a universal system have been laid. But while boys can learn to speak Latin correctly in school, it is out of school hours that they must learn to speak it fluently. If the head boys in a school could be made to see that they will render valuable service to their country by setting a good example and speaking Latin in the cricket ground, football field, and in talks amongst themselves, the small boys will immediately follow suit, it will become the fashion to talk Latin, and very soon every boy in the school will speak Latin as fluently as he speaks English. But to gain the approval of the boys, Latin ought to be taught in a different way from what it usually is, and the making of Latin verses should be left out, for though it may be useful in after-life to scholars and literary men it is useless to most others, it consumes a great deal of time, and it is intensely disliked by most boys. Greek should be regarded as a luxury and not as a necessity.

The need of a universal language has been making itself more and more felt of recent years in proportion as intercommunication between different countries has increased. In order to supply this want various attempts to frame a universal language have been made, such as Volapuk and Esperanto. Though a certain amount of success has been claimed for both of these, yet neither has attained to anything like the position of a universal language.

As compared with Dutch or Germans, and especially with Russians, Englishmen are, in general, very poor linguists, and I think it is partly in consequence of this that German commerce has, before the war, been successful in many countries at the expense of the English. When this awful war is over, Germany will again try to oust the English from the world's commerce, and to embroil the present Allies with one another by every means that ingenuity and malice can suggest. Unless Englishmen all learn to speak French, Italian, and Russian, how can the necessary rapprochement be kept up? French and Italian are comparatively easy, but Russian is very difficult, and it may be the most necessary of all. Latin may not be taught at present so universally in Russian as in English schools, but if Latin were adopted by the English, French, Italian, and Russian Governments as the recognised medium of intercommuncation there can be little doubt that in a very short time Latin would resume the place it once held as the language in universal use all over the civilised world.

LAUDER BRUNTON.

Belgian Soldiers in Holland.

WE venture to appeal to men of science to help in the admirable work which is being done by Prof. Antoine, of Louvain, on behalf of Belgian soldiers who escaped with our Naval Division from Antwerp, and are now interned in Holland.

With the sympathetic approval of the Dutch authorities, Prof. Antoine has organised at Harderwijk, in the camp of Zeist, courses of instruction in agriculture and horticulture, and hopes to start a course of forestry.

Lectures are given in elementary botany, chemistry, and surveying. In addition to these general lectures, special courses are given on general agriculture, diseases of plants, agricultural machinery, book-keeping, the elements of zoology, and animal physiology of farm animals. A general course in dairy work, and special courses on the chief branches of horticulture are also to be included in the programme. Three airy and well-lit rooms are available for the purpose of instruction, but there is a great need for teaching accessories—diagrams, models, and collections. We appeal, therefore, to your readers for help in supplying the following requisites:—

(1) Wall diagrams, botanical and zoological (the latter relating to insects and farm animals).

(2) An electric lantern and lantern-slides illustrative of natural science and agricultural and horticultural processes.

(3) Books on British agriculture and horticulture.

(4) Surveying instruments.

(5) Zoological and botanical models and specimens.

(6) Microscopes, simple and compound, and accessories.

We shall be greatly obliged if those of your readers who are in a position to make contributions will, in the first place, communicate with M. H. van Orshoven, Comité Officiel Belge, 21 St. James's Square, London, S.W.

With a list of promises before us, we shall be in a position to prevent unnecessary duplication of gifts from those willing to help in this good work. Already direct appeal to manufacturers, publishers, and others has resulted in many gifts of samples of feeding-stuffs, fertilisers, seeds, books, diagrams, etc. We may add that at the end of the war, Prof. Antoine proposes to present the collections to the University of Louvain.

Judging from our own experience, there are few laboratories which do not contain diagrams and appa-

ratus which, though they have passed out of current use, are none the less valuable. A spring-cleaning of the laboratories would result in many useful discoveries of this kind, and the dedicating of them to this purpose would "bless him that gives" as well as "him that takes."

WILLIAM SOMERVILLE.
FREDERICK KEEBLE.

Germany's Aims and Methods.

THOSE of us whose educational experience has taught us to see behind the scenes of English official life in scientific matters for the last two or three decades will be prepared to endorse the scathing indictment brought against English officialdom by Sir William Ramsay in his article in NATURE of January 27, on "Germany's Aims and Methods." My own experience, extending over eighteen years as the senior science master of Wellington College, led me to form conclusions which were put forward in the 'eighties and the 'nineties through the editorial courtesy of NATURE, and are therefore easily accessible. To give pointed illustration of this, I may quote a remark made more than twenty years ago to me in a letter from a professor at the Royal Military Academy, Woolwich, where cadets were trained for the artillery, and (prospectively) for the Royal Engineers. He spoke with just indignation of science being treated as the "fifth wheel of the coach." Germany has made it the *first* wheel of her coach, and has startled the British public by the discovery that the Germans seem to be very clever people, as the scales have fallen from unwilling eyes, and the academical nose has learned that experimental chemistry and research are something more than "Stinks."

Sir William Ramsay rightly condemns the principle of selection for the Civil Service, and no one with first-hand knowledge of the facts will gainsay his conclusions on that head. But that covers only a part of the ground; and we need not hesitate to say that, if the brain-energy expended in the controversies about the retention of Greek at Oxford and Cambridge in the past twenty or thirty years had been directed towards making *some one branch of science essential* (along with the present minimum of mathematics) *for all degrees,* the outlook for England in this war would have been brighter than it is to-day. The country would also have been saved from the evil results of blank vacuity of mind on elementary matters of science on the part of the majority of our statesmen and legislators, who receive their 400*l.* a year as members of the House of Commons, while the more general application of scientific ideas and methods to commerce and manufactures might have saved us from the disadvantage at which we are placed in this world struggle, as this war is opening people's minds to see (not without alarm) how many things we had allowed ourselves to become dependent on Germany for in the course of a generation. A. IRVING.

Bishop's Stortford, January 31.

Instruction in Science for Military Purposes.

IN response to requests from a number of important centres, I subjoin a syllabus covering the essential points to be taught to officers, N.C.O.'s, and men who have only a limited time at their disposal taken from other military duties. Experience has shown that much valuable work may be done by following on the lines suggested, all extraneous matter being excluded. The scheme has been found to be satisfactory for all ranks; in the case of officers, however, who have had some previous training in science, the matters may be treated in a more advanced manner. Teachers will find N.C.O.'s and men very keen and intelligent, and completely useless men quite rare. An excellent chance is now afforded by the men called up under Lord Derby's scheme, of which all teachers who can should avail themselves.

In arranging for a class regular attendance should be insisted on. Reports on the abilities of each student are much appreciated by commanding officers, who are thereby assisted in making a correct choice for special duties. All lectures should be illustrated by experiments so far as possible, and parts of instruments described by reference to good-sized models, or, failing these, well-executed diagrams. A class should not exceed twenty in number, and questions should be freely invited.

FIELD TELEPHONES.

Time required, about twelve hours, of which the first three should be devoted to the elements of electricity, as required for this subject. The general ground is covered by the writer's lecture, published in the Journal of the Royal Society of Arts for September 3, 1915. All practical details will be found in "The Field Artillery Telephone," by J. Young, obtainable only from Cattermole, Woolwich, price 9*d*. The necessity of learning the Morse code should be strongly impressed on all.

Preliminary.—Vibrations; sound—analogy between gramophone and telephone. Elementary idea of electric current; pressure, rate of flow and resistance. Conductors and insulators—function of a tapping-key. Permanent magnets—action between similar and opposite poles. Electromagnets—rule for polarity.

Induced currents—induction coil—how alternating currents are produced in secondary.

Cells—meaning of + and − poles. Description of "inert" dry cell; how to test for efficiency; useful life. How to couple cells in series. Condensers—elementary notion, action on direct and alternating currents.

Service Telephones, chiefly the "D Mark III." (If the actual instruments are not available, models will be found useful.) Typical circuit for field telephones. Earth returns. Description of microphone and receiver (service patterns). Action of a single-reed buzzer. Polarised double-reed buzzer of D Mark III.: adjustments, current required for efficient working. Complete circuit of D Mark III. telephone. Circuit of Stevens's telephone. Tests for efficiency of telephones: likely defects; how remedied.

Lines.—Single and multiple lines. Repairing broken lines. Causes of overhearing. How to tap into an existing line. Telephone exchange, simple form.

Practical Work.—Examination of cells with voltmeter; connecting in series. Rewiring a transmitter and receiver. Repairing a broken line of stranded steel wire (very important). If instruments are available, one or two exercises in the field in laying lines and communicating by speech and Morse code on the buzzer may be given.

POISON GASES.

Full details of this subject are not made public. The teacher must use his judgment as to gases likely to be used; chlorine may be taken as typical. The best absorbents of each gas should be stated, together with information about helmets and their proper use. Stress should be laid on the necessity of complete absence of exertion and administration of oxygen in rendering first aid to a sufferer. A description of oxygen apparatus as used in mines should be given. Two or three hours may be given to this subject.

RANGE FINDERS.

Lectures on this subject should be directed to an understanding of "one-man" range finders, and par-

ticularly to the Barr and Stroud type. A full description of Service instruments may be found in the "Handbook of Artillery Instruments," 1914 (Wyman and Sons, price 1s. 6d.).

Reflection of light from plane surfaces. Reflecting prisms. Bending of a ray of light by prism. Lenses, positive and negative. The mekometer. Full description of Barr and Stroud range finder. Time required, about three hours.

EXPLOSIVES.

In general, it will be found advisable to restrict the teaching of this subject to officers, the treatment being decided by the time available and the previous chemical knowledge possessed by the class. The common explosive compounds and mixtures may be dealt with, stress being laid on the precautions to be taken in handling. The Service "Text-Book of Explosives" may be consulted, but can no longer be regarded as up to date. Beyond imparting general ideas and useful hints, this subject is too specialised for the average teacher to undertake to advantage.

It is hoped that the above hints will prove of service to the numerous correspondents who wrote me concerning my letter in NATURE for January 20, to whom I have not been able to reply individually. The syllabus may be amplified at the discretion of the teacher if time permits. What is here given is the minimum information that should be imparted.

CHAS. R. DARLING.

City and Guilds Technical College, Finsbury, E.C.

A LAND OF DILEMMA.[1]

THE most perplexing Australian problem is that of the Northern Territory, and all interested in the present efforts to solve it will welcome Miss Masson's interesting sketches of that vast land of dilemmas. The book deals with various phases of life and work in the Northern Territory, and records the impression of a keen and sympathetic observer who had unusual opportunities for insight into its present condition and prospects. The work owes part of its charm to its graphic expression of the attractiveness of the country and the author's friendly sympathy with all classes of its people. The first chapter gives an excellent summary of the political history of the Territory, which began with a jealous scramble between South Australia and Queensland, who were inspired by blind lust for acres; it records the slow disillusionment of the successful claimant, the transfer of the country to the Commonwealth, and the attempts now in progress to discover its possibilities and determine the best methods of developing them.

The author indicates the chief questions which the country is putting to its administrators, but does not answer them. She is doubtful whether the aborigines can be saved from extinction, and bears emphatic testimony to their amiability and intelligence.

"The quickness of the average native is a surprise to those who have always heard that the Australian aboriginal belongs to one of the lowest races extant. The blackfellow's mind is that of an absolutely uneducated, intelligent child. He has the same acuteness of observation, the same power of mimicry, the same irresponsible nature, the same unerring sense of justice that tells him whether he is being fairly treated or no. He is as unhesitating in his likes and dislikes, as difficult to compel, as easy to persuade" (p. 154).

Native paintings on a rock near the Alligator River. From "An Untamed Territory."

Miss Masson explains that the demoralisation of the blackfellows has been due to the Chinese, and gives an illuminating account of the trial of some blacks for the murder of a white trader. Of the guilt of the accused there was no real doubt, but the court obviously gave them every advantage; some of them, though clearly guilty, were acquitted owing to a technical lack of evidence, inevitable when legal processes evolved in the Old Bailey are adopted in untamed bush. The death sentence on those convicted was altered to imprisonment for life in the luxurious security of the Darwin jail. The account of the trial leaves

[1] "An Untamed Territory. The Northern Territory of Australia." By Elsie R. Masson. Pp. xii+181. (London: Macmillan and Co., Ltd., 1915) Price 6s.

an impression of bewildered justice, loth to judge blackfellows by European standards and yet conscious of the added jeopardy to the defenceless pioneers by failure to avenge a murdered settler. Miss Masson does not hide the difficulties with which the Northern Territory is confronted; she notes the high and rising cost of labour and the need for faith and patience. Statistics throw little real light on the present progress of the territory; so Miss Masson's sketches should prove a contribution of permanent value to its literature, as an instructive picture of the country during the most critical stage in its development.

J. W. G.

OPTICAL INSTRUMENTS AND THE MINISTRY OF MUNITIONS.

AT the end of November, 1915, there appeared in the *London Gazette* a notice issued by the Minister of Munitions under which power was taken to commandeer all optical instruments of importance for the defence of the realm. Since that date the Ministry of Munitions has been examining the available supply of such optical instruments, both in manufacturers' and dealers' hands. The examination, which has been a very heavy piece of work, had for its purpose the enforcing of certain restrictions placed upon the sale of such instruments under the Defence of the Realm Act Regulations, 1914, and it was recently announced that traders can only offer such instruments for sale if and when they are specially marked. The announcement appears in the January Army Order, in which it is stated that "two marks will be used, one indicating instruments which do not come up to the standard Government requirements, and the other instruments which come up to the required standard but are not required by the Government."

The instruments scheduled in the Order in Council are prismatic and Galilean binoculars, portable terrestrial telescopes, telescopic sights for rifles, periscopes and hyposcopes, prismatic compasses, as well as range-finders, mekometers, telemeters, clinometers, angle of sight instruments, apparatus for control of fire, dial sights, directors, and field plotters.

It will be noticed that the announcement does not specify for the information of general readers the actual marks which are being used; and, therefore, it will probably be of interest to describe them here. The first of the marks referred to is the broad arrow with the left-hand barb omitted, thus: . This mark is engraved or otherwise marked on instruments which have been examined under the instructions of the Ministry of Munitions and come within the terms and schedules of the Order in Council referred to above, but do not fulfil all the conditions specified by the Government as necessary for naval or military service. The instrument is not necessarily defective, but the mark means that in some optical or mechanical detail or details it is considered unsuitable for naval or military use. It would, therefore, be well for an intending purchaser to examine carefully an instrument bearing the mark.

The second mark which may be found upon such instruments is the broad arrow with the stem omitted, thus: . This has been engraved or marked upon instruments which satisfy the Government's specification as instruments suitable for naval and military use, but not at present required by Government, and which therefore, presumably, may be disposed of by traders. Such instruments have satisfactorily passed the Government tests.

Instruments which do not come within the terms of the Order have not been marked, such instruments not being of the types required in quantity by the military authorities.

Although measures have been taken to secure for the purposes of the State all suitable optical instruments in the hands of makers and dealers, many more seem to be required, judging from the following announcement made a few days ago:—

> The Ministry of Munitions and the management of the Lady Roberts's Field-Glass Fund desire to give publicity to the fact that there is still a great demand for the supply of field-glasses and telescopes for the troops in the field. Both prismatic and ordinary field-glasses are required, but not opera-glasses. The owners of such instruments are urgently requested to place them at the disposal of the fund, either by way of loan or sale. It is hoped that owners who are unable to lend their instruments will, in any case, be willing to sell them to the Government at a valuation figure. With this object in view, the Ministry of Munitions has made special arrangements to value any instruments offered for sale if found suitable for military or naval purposes, and payment will be made by the Ministry in accordance with the valuation figure. Instruments unsuitable for military or naval purposes will be returned to the senders. All instruments sent in, whether for loan or sale, and all letters should be addressed to the secretary, Lady Roberts's Field-Glass Fund, 72 Victoria Street, London, S.W.

The necessity for Government taking such steps at this critical time to supply the requirements of the naval and military authorities is an ample and striking justification for the demand, to which reference has been made from time to time in these columns, for the establishment of a National Institute or School of Technical Optics, which would have for its main object the placing of this country in a position in the future in which it would not be dependent on any foreign country for an adequate supply of instruments so vital for modern naval and military efficiency. Incidentally, such an institute would also secure national independence in the supply of the still more numerous and highly specialised optical instruments so essential in the arts of peace.

The importance of the subject has long been insisted upon by the British Science Guild, and the Technical Optics Committee of the guild has prepared several valuable reports upon it. This committee, after a full investigation of the evidence available, shortly after the outbreak of hostilities forwarded to the Board of Trade a report,

which was published in NATURE of March 25, 1915 (vol. xcv., p. 103), pointing out the urgent need for the provision of adequate facilities for systematic scientific and manual training in technical optics, and referring to recommendations made in July, 1914, for the establishment of a national institute, but no official action appears to have resulted. The main points of the position of the country as regards the manufacture of optical instruments and related matters are clearly stated in the report to which we have referred, and a course of action is indicated. Lack of official encouragement has been largely responsible for loss of our optical trade in the past, and for the action which the Ministry of Munitions has now had to take to provide sufficient instruments for purposes of war. If the Government neglects to provide for the future in a matter of such national importance as the promotion and development of scientific optical manufacture, it will lose an opportunity never likely to occur again. The need for a national institute is undoubted, and the outlay required is so small in comparison with the advantage to be gained by its establishment, that we cannot believe the delay in dealing with the matter is due to financial considerations, but rather to want of knowledge and to official incompetence.

THE SOUTH AFRICAN SEA-FISHERIES.[1]

THIS report is of considerable general interest, since it contains an account of the development of the sea-fisheries in South African waters and a discussion of the factors, real and problematical, affecting the general productivity of the fisheries. Trawl-fishing by means of modern vessels began early in the 'nineties of last century, but for one reason or another most of these early enterprises were not successful. In 1895 the Cape Government took the matter up, and arranged to carry out a general biological survey. A steam vessel, the *Pieter Faure,* was designed and built specially for this work, and various new trawling grounds were discovered and investigated. As a result of this preliminary survey various private fishing companies began operations, some of which were unsuccessful. At present there are about eight steam-trawlers regularly engaged in fishing in South African waters, and an industry, limited in its scope, has apparently been well established. Such statistics as are available show a general rise in the productivity of the fishery, or at least, that it is being maintained; it is difficult to be certain as to the trend of the figures.

In South Africa, as in home seas, there have been misgivings as to the effect on the continuance of the yield of fish of various causes. Fluctuations occur and cause much discussion and demand for remedial measures, or prohibitions and restrictions by legislation. In the case of a fishery where these fluctuations may be due to natural, uncontrollable changes or factors, or to variations in private enterprise, or to causes, such as over-fishing, which can be controlled, it is always difficult to know what is best to be done. Many of the causes alleged for the supposed diminution of the Cape sea fisheries seem to European readers to be imaginary. The noise and disturbance due to the running of trains along the sea-coast; firing guns; the use of dynamite; sea birds, seals, and porpoises; the increase of shipping, etc., would scarcely be regarded in Europe as competent causes. Nevertheless, the sea fisheries off the South African coast are very restricted, and factors which we could scarcely regard as operative in the North Sea may be significant in South African waters. A very good case is made out in the report for the destruction of large numbers of sea fishes by sudden changes in sea temperature due to the extension of cold bottom currents; by changes due to local submarine volcanic disturbances; and by the fouling of the water by masses of decaying plankton. All these are surely matters for scientific investigation, and this is all the more desirable since they are matters of exceptional marine biological interest. The really important thing in relation to the South African marine fisheries at present—more important than the promotion of private enterprises—is good, well-equipped, scientific, and statistical investigation.

The report deals with other matters of special interest. The crawfish (*Iasus lalandii*) has become a very important economic crustacean, and fairly large quantities are now canned and exported. It is the object of very careful fishery observations, and of good zoological investigation. There are reports on the destruction of fish and fish-spawn by netting; very interesting and well-written observations on the habits of South African fishes; an account of the snoek-fishes (allies of the mackerels); descriptions of three new species of marine fishes; and the first part of a catalogue of South African fishes in general. The volume is, altogether, one of much interest and value to science, apart from its special objects in relation to the local fishing industry. J. J.

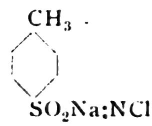
[1] Marine Biological Report No. 2, for the year ending June 30, 1914. Pp. 167+2 charts. (Union of South Africa, Cape Province, 1914.)

NEW ANTISEPTICS.

BRIEF notices have already appeared in the Press and a fuller account in the *British Medical Journal* (August 25, 1915) on the use of sodium hypochlorite solution, made slightly acid with boric acid, for the treatment of wounds. This solution was first introduced by Dr. Dakin and applied with great success in the hospital at Compiègne and in other military hospitals. But this was not the only antiseptic submitted to examination and experiment at the Compiègne hospital.

An account by Drs. H. D. Dakin, J. B. Cohen, and J. Kenyon has just appeared in the *British Medical Journal* (January 29, 1915) on *chloroamine.* This compound, like many others in which

chlorine is linked to nitrogen, has strong germicidal properties. It has the following structure:



and was first prepared in 1905 by Dr. Chattaway, who, however, did not discover its antiseptic action. It is most conveniently obtained by adding sodium hypochlorite to toluene sulphonamide. It is a colourless, crystalline substance, which in the solid form is quite stable, and when dissolved in water can be kept unchanged for many months. It is without corrosive action, is non-toxic, and does not coagulate protein. Its germicidal action is, molecule for molecule, about four times that of sodium hypochlorite. It is, however, less irritating than the latter, and can be used at a concentration five to ten times as great.

A report from Staff-Surgeon A. R. Fisher on the use of chloroamine in the treatment of wounds of the mouth and jaw appeared in the *British Medical Journal* for January 15, and the cases described, though few in number, are reported as "distinctly encouraging." Finally, mention may be made of the use of electrolysed sea-water for the disinfection of hospital ships. The large number of sick and wounded recently brought home from the Near East in hospital ships made the question of disinfection imperative. Though the production of hypochlorite by the electrolysis of salt solution for bleaching purposes, and the powerful antiseptic properties of hypochlorite so produced, have long been known, the idea of electrolysing sea-water on the vessel which is to be disinfected is a novel one, and due to Dr. Dakin, who has successfully solved the problem of disinfection in this simple, cheap, and effective way. The apparatus consists of an electrolytic cell, which, with a current of 65–75 amperes and 110 volts, yields a solution of 2 parts per 1000 of hypochlorite in five minutes at a cost of about 3*d*. per 100 gallons. This solution, diluted with an equal volume of sea-water, is sufficiently strong to sterilise floors, decks, latrines, etc. It has been used on the *Aquitania* on her last two voyages, with excellent results.

NOTES.

SINCE we went to press last week the report of the Committee on Retrenchment, which led the Government to decide on the closing of museums, has been published. We have not space here to analyse its arguments, but this is the less necessary since they were speedily countered in a letter to the *Times* of February 4 by "A Biological F.R.S." This seems to have closed the newspaper discussion, and we are now waiting to see the effect of to-day's deputation to the Prime Minister, organised by the Museums Association. Among the speakers will be Lord Sudeley, Sir Ray Lankester, and the director of the National Museum of Wales. The petition to be presented has been signed by leading men in all parts of the country. The provincial museums recognise that the action of the Government is intended as an example for them to follow, and they fear that they may be subjected to pressure through the Local Government Board. They will not, however, submit without a protest, and that protest will be made on purely patriotic grounds, for the municipal and other museum authorities know very well the admirable educational work that is being carried on among all classes of the population by their institutions. It is not only in London that our soldiers are deriving pleasure and profit from the museums; at Colchester, for example, the presence of soldiers in training has raised the annual attendance from 29,564 to 339,933, to which latter figure must be added some 18,000 for Sunday afternoons in the winter months. Meanwhile, it is stated by the *Neue Freie Presse* that in Germany and Austria all libraries, museums, and picture-galleries are open as usual, and the reasons given for closing them in this country are regarded as "a declaration of moral bankruptcy," more striking than the economic weakness which so fatal and futile a decision is held to reveal.

AT the annual general meeting of the Society of Public Analysts, held on February 2, Mr. G. Embrey was elected president for the ensuing year.

THE Royal Swedish Academy of Science in Stockholm, has elected Prof. E. B. Poulton a foreign member as a token of its appreciation of Prof. Poulton's work in zoology, and especially in entomology.

THE work of completing the laboratory building and first range of plant houses at the Brooklyn Botanic Garden is now proceeding. We learn from *Science* that the completion of these buildings at this time has been made possible by the donation, by three friends of the garden, of 20,000*l*. on the condition that a like sum be appropriated for the same purpose by the city of New York.

AT the meeting of the Chemical Society held on February 3 the second of the series of lectures arranged by the council to be delivered during the present session was given by Prof. W. H. Bragg, who chose as his subject, "The Recent Work on X-Rays and Crystals, and its bearing on Chemistry." Dr. Alexander Scott, president, was in the chair, and the meeting was largely attended. After the delivery of the lecture, a discussion was held, in which Prof. H. E. Armstrong, Mr. William Barlow, Lieut. Bragg, and Sir William Tilden took part.

THE death of Prof. John Wyllie, emeritus professor of medicine in the University of Edinburgh, occurred on January 25 at the age of seventy-two years. Prof. Wyllie held various appointments in Edinburgh hospitals from 1868 to 1900, when he succeeded Sir Thomas Grainger Stewart as professor of medicine in the University, and occupied the position until 1914. His chief published work on the disorders of speech was published in 1894. He was also the author of a number of papers in medical journals.

MR. C. W. BEEBE, curator of birds to the New York Zoological Society, has sailed for British Guiana, where he intends to establish a tropical zoological station for observation and research. His primary

object will not be the collection of specimens—though he hopes to send home a steady stream of living creatures with special attention to the rarer types—but the intensive study of birds and animals in their own haunts. He proposes to build a bungalow at the edge of the jungle, and to equip it with a complete laboratory outfit. The Government of British Guiana has offered Mr. Beebe the use of its botanical gardens and of wild Government land. His associates in this expedition will be Mr. I. Hartley, Mr. P. Holmes (whose interest is in photography and work with insects), and Mr. Carter, a collector.

THE shortage of synthetic dyes in this country and the United States has naturally greatly increased the demand for certain vegetable dyestuffs, which have in their turn risen in price, and in some cases are proving very difficult to obtain. In particular there has recently been a serious scarcity of logwood in this country. In the past the chief British sources of supply of this wood have been Jamaica and British Honduras, but some years ago the Imperial Institute investigated the possibility of exporting logwood from another British Colony—Mauritius. A trial shipment of this logwood was found to be of excellent quality, and in 1912 an offer to take a considerable quantity of the wood was obtained from a leading British dye firm. At that time, however, the price offered for the wood was not high enough to encourage the export, but, in view of the higher value at present ruling, the Imperial Institute has now succeeded in arranging for a considerable supply of Mauritius logwood to be utilised in this country.

A BRITISH Industries Fair is to be held by the Board of Trade in the ground floor courts of the Victoria and Albert Museum on February 21–March 3. The co-operation of the Board of Education, in permitting the use of the museum for the present practical object, is, says the *Times*, a healthy evidence of the desire of the Government to give to British industries and manufacturers some of that official assistance and encouragement by which the commerce of other countries, of Germany especially, has been so largely built up. For the forthcoming fair at South Kensington the Board of Trade has already sent out some 20,000 invitations to probable buyers in foreign countries, and invitations will in due course also be sent to about 80,000 persons in the British Isles, the names having been largely compiled from lists of customers which the manufacturers themselves have put at the disposal of the commercial department of the Board. The manufactures included in the exhibition will be: (1) toys and games; (2) china and earthenware; (3) glass; (4) fancy goods; and (5) printing and stationery.

DR. J. G. BOWMAN, of Chicago, director of the American College of Surgeons, is reported by *Science* to have stated recently that the college has obtained from its fellows an endowment fund of 100,000*l*., to be held in perpetuity, the income of which only is to be used in advancing the purposes of the college. The college has been in the process of formation for the last three years. It has a temporary office in Chicago, and it is probable that permanent headquarters will be decided upon within a few days. The president is Prof. J. M. T. Finney, head of the surgical clinic of Johns Hopkins Hospital, Baltimore. The college is modelled after the Royal College of Surgeons of England, and has the support, it is said, of nearly all the leading surgeons in the United States and Canada. The college, which is not a teaching institution, but rather a society or a college in the original sense, now numbers about 3400 fellows in Canada and in the United States.

DR. RODOLPHE ENGEL, whose death was announced in NATURE of January 27, was born at Fegersheim, in Alsace, in 1850. His father, who was professor of botany in the faculty of medicine at Strassburg, was transferred after the Franco-German war to the new University of Nancy, where his son, after serving his time in the army, completed his studies, and was the first doctor of medicine of the new faculty. Shortly after he graduated doctor of science at the Sorbonne, and became successively professor of chemistry in the faculty of medicine at Montpellier and at the Ecole Centrale des Arts et Manufactures, where his teaching powers were greatly appreciated. Prof. Engel devoted himself to both pure and applied chemistry. Thus he investigated creatine, taurine, the synthesis of aspartic acid, the allotropic form of arsenic, and many crystallised hydrochlorides of metallic chlorides. It was to Engel's ingenuity that the process of transforming potassium chloride into carbonate in the cold by the intermediate formation of a double salt of magnesium is due, a process which was exploited by Germany and used at Strassburg for many years. Prof. Engel was also engaged in the commercial production of plastic substances such as viscose.

MR. E. HERON-ALLEN has been elected president of the Royal Microscopical Society for the ensuing year. In his presidential address, delivered on January 19, he referred to the extensive field now covered by work in microscopy. The microscope is now an indispensable adjunct, not only to every branch of science, but also to most trades. But though its applications have thus been widely dispersed, its essential and peculiar scientific principles remain as a field of specialised scientific inquiry, and this becomes more apparent every day in these times of profounder and ever-widening research. At the present time the society has an excellent opportunity of increasing its influence on the development of microscopic technique and appliances, and the programme for the new session should attract to the meetings many fellows of the society, as well as other scientific workers. Next week Messrs. Rousselet, Earland, and Heron-Allen will give an exhibition, and a joint paper "On the Progress and Development of Vision and Definition under the Microscope." In March Prof. J. Arthur Thomson will deliver an address on "Original Factors in Evolution"; and in April Prof. Benjamin Moore, one on "Early Steps in the Evolution of Life." Later, Mr. J. E. Barnard will deal with the progress and results of some of his studies in branches of microscopic research. A paper is expected from Prof. S. J. Hickson, and one by Mrs. Helen P. Goodrich, upon the history of, and the recent work done

upon, the mysterious dental disease known as pyorrhœa. At all the meetings a special feature will be made of the technical methods to be employed with the view of showing the obtained results in the highest perfection which the progress of scientific microscope construction has rendered possible.

IN the January number of *Science Progress* Dr. F. A. Mason gives a second instalment of his article on the influence of research on the development of the coal-tar dye industry. This deals first with the synthesis of substantive dyes, and then with the technical production of indigo, the new vat dyes, and the sulphur colours. A very interesting account is given of the indigo problem. "In 1880 a step was taken which could only have happened in Germany, and where the boards of directors were composed largely of able and far-seeing chemists: the two great firms of the Badische Company at Ludwigshafen and Meister, Lucius, und Brüning at Hoechst joined forces in order to attack the problem systematically, and entered into an agreement to carry on researches conjointly, sharing profits and results." It was only after nearly twenty years that the problem was solved, and then the solution came as the result of an accident; it is now well known that the commercial success of the manufacture of indigo had its origin in the accidental breaking of a thermometer in the naphthalene undergoing oxidation to phthalic acid by strong sulphuric acid. The presence of a trace of mercury acting as a catalyst, and so enormously improving the yield of phthalic acid, made possible the artificial productions of indigo at a remunerative price, and led to the gradual extinction of the native industry, which formerly was valued at four or five millions sterling. The interesting later competition between the naphthalene process and the phenylglycine process is dealt with, as well as the connection between this industry and the development of processes of making liquid chlorine, hydrogen, and synthetic nitrates, which have played so important a part in the present war.

WHETHER the differences in the choice of food exhibited by the crossbill in Ireland are to be attributed to tastes formed by these immigrants in separate centres of dispersal is discussed by Mr. C. B. Moffat in the *Irish Naturalist* for January. The birds which effected a settlement after the invasion of 1888 showed a decided preference for the cones of the larch, while those which formed part of the invasion of 1909 chose rather the cones of the Scotch fir. Observations made during the summer of 1915 showed that while larch cones were abundant they were comparatively neglected in favour of the Scotch fir. The author also casts doubt on the generally accepted belief that the cones of the Spruce fir form the staple food of the common crossbill, in the Continental parts of its range, those of the Scotch fir being exclusively eaten by the larger parrot crossbill.

FROM the annual report of the Department of Agriculture, Nyasaland, we learn that the extension of tea-growing in the Mlanje district is very satisfactory and that good prices have been realised. Cotton is still the most extensive cultivation in the Protectorate, but the commercial cultivation of Egyptian cotton has now ceased after exhaustive trials, the type compared with Nyasaland Upland proving unprofitable, probably owing to its sensitiveness to climatic variations and to its susceptibility to bacterial blight. The total acreage under cultivation in the Protectorate is a good deal less than that reported in the previous year, largely due to the abandonment of Ceara rubber and to the sad loss of several of the younger planters in the defence of Karonga. Afforestation at Zomba and Mlanje with the native Mlanje cypress (*Widringtonia Whytei*) is being continued, and the extensive Eucalyptus plantations near Zomba and Blantyre have made remarkable growth. This tree is undoubtedly destined to be the fuel tree of Nyasaland.

A GREAT deal of useful information about Egypt is contained in the Egyptian Government Almanac for 1916 (Cairo: Government Press), a small paper-covered volume costing one shilling. It is, in fact, an epitome of the geography, commerce, industries, Government and public services of the country. There is even a list of the Government publications, the only omission in which is a summary of the maps published by the survey department. There is, however, a short article dealing with the work of the survey.

A MAP of South and Central Africa on a scale of 1 to 5,000,000 has just been published by Bartholomew. The coast from Dar-es-Salaam to Mombasa is shown in an inset on an enlarged scale, as are also the principal ports. We notice that South-West Africa is outlined in red, and the colouring of German East Africa and the Cameroons may be considered transitional, as the brown colour appears only as a border. The map is finely executed and clear, and should be useful in following the forthcoming operations against the Germans in East Africa. There are one or two corrections in the railways needed. Upington and Warmbad are now linked by rail—an important factor in General Botha's subjugation of South-West Africa. The map is sold at half a crown.

IN the course of a lecture on the romance of the Indian Surveys (Journal of the Royal Society of Arts, January 21) Sir Thomas H. Holdich commented on the policy that the Indian Government had shown with regard to frontier exploration since the war with Afghanistan. Up to that time a good deal had been done by individual effort, which was then discouraged, if not forbidden, by Government. While the discountenance of irresponsible travellers may be necessary in the interests of the peace and security of the frontier, it is a policy that cuts two ways. Undoubtedly it has curtailed the possibilities of seizing on favourable opportunities for securing geographical knowledge. For half a century we learnt nothing of the wild border hills fringing the great plateau of Afghanistan and Baluchistan, or of further Kashmir, or the great Tibetan tableland, all of which, from a military point of view, it was essential we should know. Sir Thomas Holdich contrasted this policy with that pursued by Russia during the same period, or that which would most certainly have been pursued by Germany had she been in our place, and he doubts whether the excessive caution of our Government was not misplaced.

THE State Geological Survey of Connecticut, U.S.A., has published a useful illustrated summary of the fossils of the well-known Triassic formation of the Connecticut Valley, by Prof. R. S. Lull, of Yale University. It is now generally agreed that the rocks themselves are deposits formed on continental land, either in lakes or streams, or accumulated by winds, and their chief interest consists in the large areas covered with the well-preserved footprints of reptiles and other animals. Prof. Lull devotes attention chiefly to the footprints and to a discussion of the few reptiles already known from the same formation which may have made some of them. The large majority of the footprints are evidently those of dinosaurs, but a few are more satisfactorily ascribed to primitive crocodilians.

WE have received from the Peabody Museum of Yale University reprints of four papers by Prof. R. S. Lull on the distribution of dinosaurian and mammalian remains in the Cretaceous formations of Wyoming, and on the skeleton of a Pleistocene ground sloth, *Mylodon harlani*, from Rock Creek, Texas. With the Mylodon were found a nearly complete skeleton of the extinct horse, *Equus scotti*, and remains of a new species of horse, which are described in another paper by Mr. E. L. Troxell. The Cretaceous and Tertiary remains of birds in the Marsh collection in the Peabody Museum are catalogued and described by Dr. R. W. Shufeldt in a paper reprinted from the Transactions of the Connecticut Academy (February, 1915). The fossil cycads in the same collection are still being studied by Dr. G. R. Wieland, with valuable results; and the Palæozoic fossils are dealt with by the director of the Palæontological Laboratory, Prof. Charles Schuchert, who is to be congratulated on the activity which the Yale school continues to display.

THE unusual size of the science reports of the Tôhoku Imperial University, Sendai, Japan, is partly atoned for by the beauty of their photographic illustrations. In No. 1 of vol. iii. (1915), Hikoshichirô Matsumoto describes "Some fossil mammals from Sze-chuan, China," and introduces us for the first time to the contemporaries of Stegodon in China. This Late Pliocene fauna resembles that of India and Java, a new genus, Proboselaphus, representing the Boselaphus of the latter. H. Yabe contributes three papers to No. 1, vol. v. (1915), the first of which, written in English, should be read in connection with Suess's conclusions as to the tectonics of south-western Japan. The third paper, in German, discusses the genus Halysites. The author, in the classification of the forms of this problematic coral, lays stress on the absence, presence, and stage of development of connecting tubes between the corallites, and illustrates this point in photomicrographs of cross-sections of the species.

THE February issue of the Monthly Meteorological Charts of the North Atlantic and Mediterranean, issued by the authority of the Meteorological Committee, includes an instructive graphic summary of the results of the exploration of the atmosphere and of highest flights of kites, aeroplanes, and balloons. It shows that the greatest height reached by a *ballon sonde* was some 22 miles, where an absolute temperature of 221° was recorded. The average height reached by *ballons sondes* is about 10 miles. The highest ascent of a manned balloon was made in Berlin in 1901, when a height of more than 10 kilometres was reached, and a temperature of 231° absolute was registered. It is noted on the diagram that above 10 kilometres no clouds occur, and that from this height to about 37 kilometres the temperature is almost the same. Above a height of two kilometres the temperature is, on the average, below the freezing point of water. Above a height of nine kilometres mercury freezes, and at about seven kilometres the average temperature is equal to the lowest ever recorded in the British Isles. The illustration shows also the heights of certain mountains and the temperatures recorded at their summits, and the general levels at which the chief types of cloud occur.

IN the annual number of the Journal of the Scottish Meteorological Society Dr. A. Crichton Mitchell gives a summary of some important investigations carried out by Dr. G. W. Walker, the head of the Indian Meteorological Department. In his search for trustworthy factors upon which might be based a possible forecast of the Indian monsoon rains, Dr. Walker has subjected the suggestions of various authorities to critical statistical analysis. He finds that a definite relationship involving a variation in the opposite direction exists between the Indian monsoon rainfall and the snow accumulation on the Himalayas, the pressure at Mauritius, and the rainfall at Zanzibar respectively. Further, a distinct relationship involving a variation in the same direction exists between the Indian monsoon rainfall and the pressure in the Argentine, and a less definite relationship of the same kind between the monsoon rains and the previous year's pressure in India. Dr. Walker shows how the various factors may be combined in an equation from which the variation from normal of the monsoon rainfall may be calculated, but the results so far obtained, while distinctly encouraging, point to the existence either of errors in the available data or of factors yet unknown. An interesting point is the demonstrated absence of any definite relationship between the Indian monsoon rainfall and the Indian temperature in May of the same year. If, as is generally held, the Indian monsoon is largely caused by the prevailing high temperature over the low grounds of India itself, one would expect that a year of high temperature would be also a year of high monsoon rainfall. Dr. Walker suggests that the absence of any relationship of the kind may be due to our ignorance of the effect of solar radiation upon the upper layers of the atmosphere, and that a high rainfall may possibly be connected with excessive heating of the upper rather than of the lower air.

THE opening of the Upper Jhelum Canal in the Punjab on December 9 last marks the concluding stage of a series of engineering operations which have extended over a period of ten years, and involved an expenditure of nearly 3,000,000*l*. It is the last instalment of the triple canal scheme, which, in its turn,

forms part of the system of seven great perennial canals distributing the flow of the Jhelum, Chenab, Ravi, and Sutlej Rivers in an equable and scientific manner over 17,000 square miles of country, otherwise, and formerly, only suitable for the raising of camels and beasts of pasture, but now adapted to agricultural development. The irrigation area of the seven canals already exceeds 4½ million acres, 1½ millions of which are devoted to wheat and ¾ million to cotton. When fully developed, the triple canal scheme will add another 1¾ millions acres to the total. The necessity for the perennial canal system arises from the fact that in the Punjab there are two distinct agricultural seasons and two annual crops, both essential to the successful financial working of the land. During the first of the seasons, that is, in the six hot months (April to September) the ground is plentifully supplied with moisture from the melting snows of the Himalayas, in conjunction with the ordinary rainfall. In the second six months, the cold period, the rainfall is at a minimum and the rivers carry but low supplies. The conservation and uniform distribution of the water is, accordingly, a matter of extreme importance. The introduction of the canals has been attended by very satisfactory results, and the complete realisation of the project will, it is hoped, prove, from an economical and administrative point of view, a success of considerable magnitude.

"When the accelerations of three points of a rigid body are given, the acceleration of any point is known." This statement has been partly verified by Burmeister and others. In the Bulletin of the American Mathematical Society (vol. xxii., 3) Prof. Peter Field shows that the problem can be solved very simply by using the expressions for the accelerations which are ordinarily given in text-books on mechanics, and by this method the kinematical meaning of the solution is also evident.

The attempts to obtain a hydrodynamical solution of the problem of eddy formation in the wake of a moving solid have hitherto met with only very partial success. A solution was attempted by Von Kármán for motion in two dimensions on the hypothesis that a steady motion exists in which the vortices retain the same arrangement relative to the body. In a paper in the Proceedings of the Royal Society of Edinburgh (vol. xxxv., 1, No. 9) Mr. H. Levy has now shown that such a distribution can never be stable. Unfortunately, the pressure equation, which the author describes as "a necessary condition in any hydrodynamical problem," is incorrect except in cases of steady motion, of which the present is not necessarily one, and the results therefore appear to require further confirmation.

The problem of the personal equation is always interesting, but somewhat elusive of direct estimation in complex operations. In the *Psychological Review* (vol. xxiii., No. 1) J. H. Harris records the results of some experiments which he has conducted for some time on subjects engaged in estimating moderately large samples of bean seeds, either for germination tests or for determining the mean weights for different seeds. The advantage of the method lay in the fact that the subject could compare his estimate with the true value, and so attempt to profit by his experience. As a result of many observations and careful computations, he finds that the personal equation is remarkably little affected by experience, while, on the contrary, steadiness of judgment is unmistakably influenced by previous experience.

Part 1 of vol. xii. of the Bulletin of the Bureau of Standards contains an account of an examination of twenty radiation pyrometers by Messrs. G. K. Burgess and P. D. Foote, of the bureau. All the ordinary types of instrument were tested, and from the results obtained a number of general conclusions are drawn. In general, radiation pyrometers behave not as perfectly black, but as grey bodies, and the law connecting the indication of the instrument with the temperature of the source deviates from the fourth power by plus or minus 0·5. The principal errors of the instruments examined were due to faulty design and construction, but dirty or oxidised mirrors may produce errors of the order of 100° at 600° C. Smaller errors may arise owing to stray reflections, convection currents, and wrong focusing. The types of black-body furnaces in use at the bureau are described, and some account is given of the use of the pyrometers for the estimation of the temperatures of non-black bodies.

We have received a reprint of an interesting article on telegraphic transmission, contributed by Major W. A. J. O'Meara to the *Royal Engineers' Journal*. He points out that during the past seventy years or so, although great improvements have been made, the source of energy almost universally employed for transmitting the signalling wave impulses is at constant potential so that square-topped waves are sent. The sine wave, he is convinced, would be preferable. He supports the views to this effect recently expressed by Lieut.-Col. Squier in a paper before the Physical Society. The sine wave is the only one which can pass through the cable without changing its characteristic form, and the harmonics required to build up the impressed square-topped wave are absorbed in the cable, and merely represent a surplus charge for each signal, which must be got rid of before the succeeding signal can be sent. Lieut.-Col. Squier's proposal is to utilise an uninterrupted alternating current of pure sine wave form, and to alter the impedance of the transmitting circuit at the zero point of the wave. This will alter the amplitude, and by making each semi-wave of either sign represent an elemental signal, but giving the dot twice the amplitude of the space semi-wave, and the dash twice the amplitude of the dot, the Morse alphabet can be sent with the maximum rapidity and efficiency.

Referring last week (p. 633) to Messrs. Isenthal and Co.'s new list of rheostats, we expressed the hope that they would continue to manufacture the resistances in England after the war. Messrs. Isenthal believe that even if after the war the present strong feeling against German-made goods should somewhat subside, a great many of their clients will always prefer to buy the British-made article. Moreover, having invested a not inconsiderable sum in the necessary machinery, press tools, and jigs required for the

manufacture of the rheostats, they hope to retain and extend the markets opened to them by the temporary paralysis of German export trade. Messrs. Isenthal also inform us that they find "by careful organisation, by manufacturing the component parts of these rheostats in very large quantities, *i.e.* practically making the whole rheostat except the winding in very large quantities," the instruments do lend themselves to mass production. Before the war they did not consider themselves justified in incurring the expense and work required for such methods of manufacture, and therefore purchased the apparatus from abroad. But they add:—"The closing of our relations with the central Continent has given just that impetus which was needed for us to set aside *ordinary* commercial considerations, hence our present facilities for manufacturing this apparatus."

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES.—Mars, now nearly as bright as Sirius, will be in opposition early on Friday. Jupiter and Venus, so conspicuous in the western twilight, reach conjunction about 3 a.m. on February 14. Their nearest approach takes place earlier, about midnight, Venus being 26′ S. Even at 7.30 p.m., February 13, they will be only 32′ apart. The moon occults a 3·2 mag. star, ε Geminorum, on February 14. As seen from Greenwich disappearance occurs at 11h. 3m. The moon is in conjunction with Neptune on the evening of February 16 at 6h. 24m. Geocentrically the planet will be 1° 2′ S. Comet 1915*e* (Taylor) can still be glimpsed with a 3-in., but is not a suitable object for such a small aperture. The following positions are from a continuation of the Copenhagen ephemeris for Greenwich midnight:—

		h. m. s.		° ′
Feb. 11	...	5 30 22	...	+24 21·3
15	...	36 45	...	25 39·0
19	...	43 48	...	26 50·8

SHIFTS OF WAVE-LENGTHS.—Modern measurement of wave-lengths, in striving successfully after an accurate third decimal figure, has begun to detect all kinds of causes that result in wave-length alterations. In solar spectroscopy, in addition to the well-known pressure and motion effects, the recondite theory of relativity and the ubiquitous anomalous dispersion championed by Freundlich and Julius respectively have afforded explanations of the observed displacements. In the one case it is an intense gravitational field that is adduced as competent; in the other the mutual effect of neighbouring lines. In the laboratory length of arc, its internal pressure, distance from pole, impurities, change of electrical conditions, have been described as the source of displacement by Royds, Albrecht, St. John, Burns, and Bilham. The latter, working in Prof. Fowler's laboratory at South Kensington, has now studied the special case where the adventitious element itself gives rise to strong lines (*Astrophysical Journal*, December, 1915). A number of iron lines in the regions of H and K were measured in the spectrum given by a carbon arc fed with Fe filings, and also when the arc was fed with a mixture of filings and calcium chloride, the calcium lines being measured in both cases. The results obtained in this very interesting research indicate that some lines are susceptible, whilst others have constant wave-lengths. The K line of calcium is found to differ by 0·008 Å. in the two sources. One hesitates to think of the array of conditions it will become necessary to introduce into the specification of standard lines.

FURNACE SPECTRA OF COBALT AND NICKEL.—To the metals (Fe, Ti, V, and Cr) whereof the electric furnace spectra have already been investigated in such painstaking and accurate manner by Dr. King, must now be added Co and Ni (*Astrophysical Journal*, vol. xlii., No 4). Fourteen pages are given up to tabular matter similar to that for the elements previously studied. Attention may be directed to some results of an unexpected character; thus not only is the violet end found relatively rich in lines, but all the enhanced lines of cobalt (except only λλ 3878·90 and 3904·23) in the region of shorter wave-lengths than λ 4077·56 have been classified as furnace lines. Another peculiarity is the fact that each of the classes I., II., and III. contain some lines that attain a maximum in the furnace and are weaker in the arc, thus affording, as regards the lines of Class III. A, a group of lines special, perhaps, to a range of temperature of some 500° C.—a feature worthy of further attention.

THE ELECTRO-THERMIC SMELTING OF IRON ORES.

THE rapid growth of the application of the electric furnace to the metallurgy of iron and steel is certainly the most noteworthy feature of the development of this industry during the last decade. Ten years ago "electric steel" was largely a novelty. To-day there is scarcely a branch of this highly diversified and complex industry in which electrothermic heating has failed to secure a footing and to justify itself. This progress is all the more remarkable when it is remembered that the steel manufacturing industry "owing to its age and importance, and also to the capital invested in it, is one of the most conservative and settled of all industries."[1]

The earliest uses to which electric furnaces were applied were to the production of (1) ferro-alloys, containing iron, carbon, and such elements as tungsten, molybdenum, vanadium, etc., which indeed cannot be made in fuel-fired furnaces; and (2) of the highest classes of carbon and alloy tool steels, where they competed successfully with crucible furnace products. Having "made good" up to this point, they were next developed, not in direct competition with Bessemer and open-hearth furnaces, but as important adjuncts to them, and within the last seven years a great variety of products—*e.g.*, gun, tyre, and axle steel, wire and plate billets, and rail and girder steel—are manufactured with their aid. Such processes may be classed as electrothermic refining, for they take the metal as delivered by the Bessemer or open-hearth furnace, and, owing to their high temperature and more neutral atmosphere, permit the formation of refractory basic and even reducing slags, *e.g.*, calcium carbide, which carry the refining of the steel to a further stage, and produce a purer and more trustworthy metal. Especially has this been the case with the manufacture of rail steel in Germany and America, where it has been found that the trustworthiness of the steel is so much increased by electrothermic refining that the railway companies are willing to pay considerably more for rails produced in this way. Mention must also be made of the application of the electric furnace to the production of mild steel castings—always a difficult operation—where a very fluid metal can be obtained, and a better separation of gaseous and other impurities. Heroult[2] recently quoted instances in which it had been found to be unnecessary to anneal such materials at all, since their properties were fully as good as those of the best rolled mild steel made in

[1] "Electrothermal Methods of Iron and Steel Production." By J. B. C. Kershaw, p. 3.

[2] Transactions of the Eighth International Congress of Applied Chemistry. New York. September, 1912.

fuel-fired furnaces. These are only some of the most important branches of steel production where the electric furnace is firmly established.

It has always been recognised that the most serious competitor the electric furnace had to meet was the blast furnace. In this case the coke performs two functions. It has to supply not only the necessary heat, but also the carbon for the reduction of the ore and the carburisation of the metal. It is only the former which can be replaced by electric heat, and the horse-power year would have to be supplied at the extraordinarily low figure of about 1*l.* if it is to compete with the modern coke-fired blast furnace. It is not surprising, therefore, that there are few localities which have been found to provide the necessary conditions for electrothermic iron-ore smelting. In fact, there are only two countries where the conditions have permitted headway in this direction to be made, viz., Sweden and California, and of these Sweden is in a much stronger position. Of unusual interest, therefore, is the recent publication of Bulletin No. 344 of the Canadian Department of Mines, entitled "The Electrothermic Smelting of Iron Ores in Sweden," by Dr. Alfred Stansfield, who visited Sweden in 1914, inspected the principal smelting works, and made a careful study of the economic operation of the furnaces, reporting on the general position as it affected the possibility of establishing a similar industry in Canada.

Two main types of furnace exist: (1) the Elektrometall furnace, in which the ore is preheated and partially reduced in a shaft before it reaches the smelting chamber; the heating of the ore in the shaft and the chemical reduction of the iron in the ore being materially assisted by the circulation of the furnace gases, which is characteristic of this furnace; (2) furnaces of the Helfenstein, Californian, and Tinfos type, in which there is no provision for preheating the ore. Any shafts employed are merely for the purpose of introducing the ore charge conveniently, and the main object of the design is to obtain a large and substantial furnace for smelting iron ores by electrical heat.

In Sweden the Elektrometall furnace has been largely used, and is in regular commercial operation at Domnarfvet, Hagfors, and Trollhättan, but experiments are being made with a modified Helfenstein furnace. In Norway, which Dr. Stansfield also visited, the Tinfos furnace is in operation on a moderate scale at Notodden. At Domnarfvet there is one 4000-h.p. furnace, producing about 30 tons of charcoal iron daily, and the output of the furnaces at the other places mentioned varies for the most part between 20 and 25 tons per diem. A considerable variety of irons, open-hearth and Bessemer, acid and basic, are produced. On June 4, 1915, seven furnaces were in operation and ten others in course of construction. The output of the furnaces is not large—compared with the 400 to 500 tons daily output of the hard-driven American coke blast furnace it is small—but it is as large as that of the charcoal blast furnaces which they replace. Dr. Stansfield concludes (p. 7):—"The electric furnace has now become a dependable and economic appliance for regular commercial use. The iron obtained from it is even better than that from the charcoal-iron blast furnace using the same ores and fuel. *The cost of making the iron, using cheap Swedish water-power, is somewhat less than in the charcoal blast furnace.* The amount of iron that can be made with a definite supply of charcoal is three times as much in the electric furnace as in the blast furnace. These considerations appear to represent the foundation of the present electric iron-smelting industry in Sweden." In fact, in this country the electric furnace is ousting the blast furnace.

That section of Dr. Stansfield's report which deals with the heat distribution and technical efficiency of the Trollhättan Elektrometall furnace is of particular importance. The large shaft of furnaces of this type depends for its effectiveness on the circulation of the gases which ascend from the hearth, as otherwise the contents would not be sufficiently heated, so that the question to be investigated resolves itself into the *desirability of the gas circulation system.* Does the circulation of the gases cause a large enough economy to justify the expense and inconvenience of the large stack and the circulation apparatus? From calculations made by Messrs. Leffler and Myström, as well as himself, Dr. Stansfield draws the following conclusions.

"(1) The heat utilised in the reduction of the iron, melting the pig-iron and slag, and in other necessary parts of the smelting operation, amounts to from 63 to 74 per cent. of the whole electrical supply, this figure increasing in the later periods.

"(2) The principal source of loss is the radiation of heat from the roof and other parts of the furnace and the heat lost in the cooling water supplied to electrode holders, collars, and other parts. These losses varied from 31 to 19 per cent. in these tests, decreasing in the later periods.

"(3) The amount of the potential energy or calorific power of the gases escaping from the furnace top varies from 84 to 74 per cent. of the heat equivalent of the electrical supply, and is in each case *more than the whole heat utilised in the smelting operation.* The object of the gas circulation is to utilise as far as possible, *in the furnace stack,* the reducing and heating power of the carbon monoxide in the furnace gases; but even when this has been done to the greatest extent that is practicable, the remaining gas has a heat value greater than the net heat requirements of the smelting operation, or about 75 per cent. of the whole electrical supply.

"(4) The sensible heat carried out of the furnace by the escaping gases is unimportant . . . and no considerable loss of heat is occasioned in the same manner by the gas circulation system."

Collecting the results of all the calculations it appears:—"(1) That without circulation the escaping gases have a heat value about equal to the net heat requirements of the furnace; (2) that with the gas circulation about one-fourth the value of the escaping gases is utilised in the furnace, thus saving about 11 per cent. of the coke and 7 per cent. of the electrical energy." It is evident, therefore, that if the calorific power of the escaping gases could be perfectly utilised the furnace could be run with a small fraction of the power that is needed at present, and that the circulating system only effects about one-fourth of the large saving that is theoretically possible. At present it scarcely looks as though this increased the efficiency of the smelting furnace to an extent commensurate with the complication and expense entailed, particularly when it is remembered that the escaping gases could be utilised for converting the pig-iron into steel. Dr. Stansfield's calculation leads him to conclude that the gas produced in making one ton of pig-iron in the electric furnace would almost suffice for the production of one ton of steel in the open-hearth furnace.

H. C. H. CARPENTER.

GEOLOGICAL WORK IN CANADA.

THE Museum Bulletins of the Geological Survey of Canada include a number of papers on natural history and anthropology, and afford a rapid means for the publication of scientific work. No. 4 ("The Crowsnest Volcanics," by J. D. MacKenzie, 1914) describes igneous rocks from south-west Alberta, and

establishes, under C. W. Knight's name of "blairmorite," a trachytic type consisting of analcite crystals up to an inch in diameter, embedded in a green and sometimes aphanitic matrix. Orthoclase (sanidine), pyroxene, and melanite also occur. The analcite arose at an early stage in the consolidation of the rock, and may amount to 75 per cent. by volume. No. 15 is also a petrographic paper, on "The Gay Gulch and Skookum Meteorites," by R. A. A. Johnston, describing and illustrating two specimens, probably from the same fall, which contain about 80 per cent. of iron and an unusual proportion of nickel, from 15 to 18 per cent.

In both Nos. 17 and 18, attention is directed to the relics of early Palæozoic strata that occur within the broad pre-Cambrian area of Ontario and Quebec. In some cases (Bull. 18, p. 22) patches of Palæozoic limestone have been preserved by down-faulting, and E. M. Kindle and L. D. Burling show that the sea in which they were formed spread very widely over the Laurentian upland south-east and east of Hudson Bay. The scarp-like southern face of the Laurentian plateau, which is so marked a feature of eastern Canada, is attributed to post-Cambrian faulting. The Palæozoic rocks have been dropped about 1000 ft. over a stretch of 300 miles, forming the lowland fringe along which the Canadian Pacific Railway runs from Ottawa to Quebec. No feature of such magnitude has been traced in the topography of the old undulating plateau on which the Cambrian strata were laid down. In Bull. 17 M. Y. Williams describes an outlier of Lower Ordovician dolomite, containing pebbles worn from the Huronian, near Haileybury, on Lake Timiskaming. Patches of Niagara strata also occur farther north, and the pre-Cambrian surface was evidently "washed by both Trenton and Niagaran seas."

In Memoir 39 of the Geological Survey of Canada M. E. Wilson describes the "Kewagama Lake Map-Area, Quebec," which lies north of Lake Timiskaming, on the watershed between the Ottawa system and Hudson Bay. Pillow-structure, the origin of which is once more reviewed, occurs very commonly in the Abitibi (Keewatin?) volcanic series. The name Laurentian is wisely rejected for the granite and gneiss of the district, since they are intrusive in the Abitibi rocks, though older than the Cobalt series. A great Quaternary lake, named Lake Ojibway by A. P. Coleman (p. 104), occupied the region during the retreat of the Labradorian ice-sheet, and laid down seasonally stratified beds of clay and "calcium carbonate," which are well illustrated on plate xxvi. The clay is assigned to the summer, and the calcium carbonate to the winter seasons. It would be interesting to have an explanation of the deposit of the latter material. From remarks on p. 105 we may be led to infer that the spring, when water flowed abundantly from the melting snows, was followed by a season of drought and evaporation; but was this dry season necessarily postponed until the winter?

Several memoirs have been recently issued dealing with British Columbia. Their photographic illustrations emphasise the frequency of great uplifted plains, in which post-Glacial streams have cut deep V-shaped notches. The Cretaceous sea, and the Eocene sea which continued it in places, were driven out of the region by an uplift accompanied by folding, after which, probably during Miocene times, "a long period of crustal stability ensued, during which what is now the Yukon plateau, as well, possibly, as the coast range and other adjoining tracts, were reduced to a nearly featureless plain" (D. D. Cairnes, Mem. 37, 1913, p. 45). The same author (Mem. 67, 1914, on "The Yukon-Alaska International Boundary, p. 27) states that the elevation of this plain took place "during late Miocene, Pliocene, or early Pleistocene time." The steep excavations made in the peneplane of the Keele Mountains, shown in plates iv. and v. of this memoir, and the continuity of much of the upland, suggest a late date for the elevation. In opposition to the older views of R. A. Daly, C. W. Drysdale (Mem. 56, 1915, "Geology of Franklin Mining Camp," p. 44) recognises the peneplane well within the Cordillera of British Columbia, and attributes its development to the Pliocene rather than to earlier epochs of denudation. On the other hand, L. Reinecke (Museum Bull., No. 11, 1915, p. 39) finds no evidence of the formation of peneplanes in the southern part of the interior plateaus of British Columbia since the Oligocene lavas were poured out. "Differences of elevation of 2000 ft. are of constant occurrence within 10 miles of each other"; the average slopes of the plateau-surfaces measure between 160 and 300 ft. to the mile; and the author states that the country before its uplift reached a stage of late maturity rather than old age. He sustains this position by a number of interesting sections.

An important petrographic detail occurs in C. W. Drysdale's memoir on Franklin Camp (No. 56). Intrusive alkalic rocks of Miocene age have penetrated at the Kettle River a conglomerate that is either Eocene or Oligocene. This was unconsolidated at the time of the intrusion, and (p. 82) "the syenite has permeated and saturated the conglomerate and fine grit for at least 50 ft. from the main contact. . . . Pseudomorphs of syenite after the more permeable pebbles and matrix occur." Even quartzite pebbles show "the presence of minute alkalic feldspars with characteristic trachytic structure." This replacement of the Kettle River pebbles has been tested by microscopic sections, and no original pebbles of alkalic rocks occur in the conglomerate. The syenite has elsewhere given rise to trachytic flows at the surface, and the trachyte, where it overlies the Kettle River formation, has penetrated at least 5 ft. down into the grit. On plate xi. a junction of trachyte and sediment is shown, where contorted films of silt are seen included in the lava as portions of a composite rock.

R. A. Daly, in Memoir 68 (1915), describes "a geological reconnaissance between Golden and Kamloops, B.C., along the Canadian Pacific Railway." He finds that the oldest known rocks of British Columbia are the Shuswap sediments, which were originally muds and sands, with some gravels, washed from a lost land-surface of quartzose, granitic, or gneissose character. The existing gneisses result from the intrusion of granitoid magmas, also pre-Cambrian, into the Shuswap series. The composite mass became uplifted and denuded, and a geosynclinal was then developed (p. 154) in the eastern belt of the present Cordilleran region. In this hollow accumulations went on from late pre-Cambrian (Beltian) to Lower Carboniferous (Mississippian) times. The sea, however, did not reach the western belt until the Upper Carboniferous epoch. The Canadian Cordillera attained its full length and breadth as a result of folding at the end of the Cretaceous period. The author (p. 157) hesitates to refer the final uplift to late Pliocene times, in face of the deformation of the Lower Miocene and older strata that took place before the Pliocene period opened. One of his most important conclusions is the continuity of deposition (p. 93) in the Beltian and Cambrian sediments of the Selkirks. The schistose nature of the Shuswap sediments leads the author (p. 44) to a useful discussion of "statical metamorphism," as recognised by Judd. The sediments were affected by the superincumbent load before their further metamorphism by *lit par lit* injections of granite. Dynamic metamorphism further modified them, and the composite gneisses associated with them, in post-Cambrian time (p. 50). The mountain-land-

scapes that illustrate this memoir are of wide interest and considerable beauty.

C. H. Clapp has described the south-east of Vancouver Island in Memoir 36 (1913). The interest of the metamorphosed volcanic and sedimentary rocks in this region lies in the fact that they are largely of Lower Mesozoic age, and have been invaded and altered, and in part replaced, by granitic batholites in Upper Jurassic and possibly Lower Cretaceous times. The gneisses thus produced finally offered a denuded surface on which Upper Cretaceous conglomerates have been laid down. The drowned valleys of the Vancouver region are shown to have become elevated by some 250 ft. since a maximum of submergence in early Glacial or Interglacial times (pp. 109 and 127). The topographical and geological maps required for use with this memoir are folded in a pocket at the end, in accordance with the present very useful custom of the survey.

The beautiful country of fjords and islands that results from the subsidence of the Cordilleran coast is dealt with by J. A. Bancroft in Memoir 23 (1913), on "The Coast between the Strait of Georgia and Queen Charlotte Sound, B.C." The Upper Mesozoic intrusions again play a large part, and the relations of the batholites to the roofs above them, and the production of "roof-pendants," like those studied by C. Darwin in South Africa, can be well seen in the deep sections provided by the fjords (p. 105). An orbicular "hornblende gabbro," which might well be called a diorite, occurs in Midsummer Island (p. 94), and is regarded as a product of spherulitic crystallisation during the consolidation of the invading magma.

The remarkable discoveries of silver-cobalt ores at a railway-cutting in Ontario only thirteen years ago led to the rise of the great mining centre of Cobalt. The mineral veins are associated with sills of dolerite (diabase), and the tracing out of the igneous sheets has greatly widened the mining area. W. H. Collins describes the "Gowganda Mining Division," west of Lake Timiskaming, in Memoir 33 (1913). As at Cobalt, the principal ores are native silver, smaltine, nickeline, and copper pyrites. The silver has been deposited as a fine network through the other minerals after their formation. Other memoirs of economic importance are Nos. 47 (1914) and 65 and 66 (1915), on the "Clay and Shale Deposits of the Western Provinces." In these references are required from the plates to the pages of the text. Plate iv. in Memoir 65, showing suspended clay in jars, is without any obvious explanation.

Prof. R. C. Wallace, of the University of Manitoba, issues a pamphlet through the editorial department of the Winnipeg Industrial Bureau on "The Geological Formations and Mineral Resources of Manitoba," accompanied by a geological sketch-map.

Among the separate sheets issued by the Geological Survey of Canada we may note Map 53A, described in Memoir 20, covering south-eastern Nova Scotia, on the scale of 1 : 250,000. The foundation-sheet and the colouring may serve as types of the beautiful work produced by the Government departments of the Dominion.

J. B. Tyrrell (Trans. Royal Soc. Canada, vol. ix., 1915, p. 89) interestingly connects all the gold-bearing veins in the pre-Cambrian rocks of central Canada with the Algoman epoch of igneous intrusion. The albite-diorites which then invaded the pre-Animikiean series seem to have been especially associated with "chrysogenesis." It should be noted that the Algoman batholites of gneiss and granite are not themselves rich in gold. The term Huronian is relegated in this paper to rocks above the great unconformity recognised by Logan and Lawson alike. Hence the Algoman epoch is pre-Huronian; but its rocks are intrusive in the Timiskaming Series, and the gold veins may occur, therefore, in the older "Laurentian" gneisses and in the Keewatin Series invaded by these masses. Mr. Tyrrell points out that the presence of gold veins in central Canada will now serve to mark the rocks in which they are found as "pre-Huronian," that is, older than the great unconformity.

G. A. J. C.

CHEMISTS AND MANUFACTURERS.[1]

AMONG the many lessons which we are learning as the result of the war, not the least important is the fact that experimental science in general, and chemistry in particular, is not merely an interesting intellectual occupation, but one of the foundation-stones on which national progress rests, and that its continued neglect could only lead to disaster, and end in our complete defeat by more progressive and far-seeing nations.

The ignorance of the value of scientific knowledge shown by our people is very great, and, unfortunately, many of our rulers are little, if at all, better informed. As a consequence, much inertia still remains to be overcome, and a great deal of leeway has to be made up. Happily, signs are not wanting that we are at last directing our footsteps on the right path, and those of us who know, and who have the real interests of their country truly at heart, will earnestly pray that our progress along that path may be certain and rapid.

At the outbreak of war, the authorities were seemingly unaware of the vast and multifarious services rendered to the State by professional chemists, and of the extent to which the welfare of the nation depended upon the adequate utilisation of their services. As a result, many hundreds of highly-trained chemists were to a great extent wasted by being put to military duties which could easily have been performed by men whose normal activities were of no special value to a nation at war.

This state of affairs lasted until a few months ago, when the authorities apparently began to appreciate the facts of the situation, and the Board of Trade issued a circular of instructions to local tribunals under Lord Derby's scheme, together with a "list of occupations (reserved occupations) of cardinal importance for the maintenance of some other branches of trade and industry." Since then the Board of Trade has issued a further schedule of "reserved occupations," in which occurs the following important paragraph :—"Chemists : Analytical, Consulting Research Chemists (not to be accepted for immediate enlistment or called up for service with the Colours without the consent of the Royal Society); Chemical Laboratories : Head Laboratory Attendants."

It will have been noticed that chemists are not only not to be enlisted, but are not allowed to enlist without the express permission of a recognised body, the only other persons in the schedule who are treated similarly being "licensed pilots, officers, and crews of vessels belonging to the General Lighthouse Authorities and lighthouse-keepers"—that is to say, men whose services are absolutely essential for the public safety.

During the past eighteen months the columns of the technical and of the general Press have been inundated with letters and with articles bewailing the neglect of chemical science in this country, and deploring the want of appreciation of the services of chemists so often shown by manufacturers. That we have shamefully neglected the claims of science is a

[1] From the presidential address delivered to the Society of Public Analysts and other Analytical Chemists on February 2, by Mr. A. Chaston Chapman.

fact of which many of us have been painfully aware for a good many years, and one which through the stern teaching of the war is gradually being brought home to the bulk of the nation. This, however, is a matter which is intimately bound up with our whole system of education, and until that system has been thoroughly reformed it is hopeless to expect that chemistry and the other experimental sciences will take their proper position.

So far as our colleges are concerned, I feel very strongly that a more thorough training in analytical chemistry is desirable, and I would, in addition, venture to suggest that the present curriculum of those chemical students who intend to become professional chemists should, whenever possible, be amplified so as to include a further year of study. During this post-graduate year, the student should be trained by thoroughly competent and specially selected teachers under conditions approximating more to those of the technical than to those of the academic laboratory.

Whilst words fail to express the indignation which one sometimes feels at the miserable wages (the word "salary" would be out of place) offered to men who have devoted several years and a not inconsiderable sum of money to their training, yet, on the other hand, the young chemist seeking a position should remember that his future lies very largely in his own hands. The manufacturer on his side must understand that in engaging the services of a young chemist from one of our universities he is getting the partly-manufactured material, and not the finished product. He should be told that his future employee is merely a well-trained apprentice who knows how to use the tools of his craft, but will have to be given time in which to find his feet and to learn something of the new conditions under which he will have to work. It is here that our university professors can do much to prevent misunderstanding and disappointment by pointing out to manufacturers the limitations of the men whom they may be recommending.

A good many manufacturers (I am not, of course, referring to the heads of large concerns where many chemists are employed, and where their functions are thoroughly well understood and appreciated) do not always know very clearly what they want. They have a vague idea that some sort of chemical assistance is necessary in a modern factory, and they consequently go to one of our colleges and state that they want "a chemist." As one of the objects of our colleges is very properly to find employment for the men they have trained, he is offered the services of a man who has perhaps just finished his chemical course, but knows little or nothing of the nature of industrial chemistry or the requirements of the factory.

It is at this point, however, that the trouble to which I have alluded commences, for the young man in question is offered to the manufacturer labelled "chemist" without any qualification at all. As a very general rule no intimation is given to the manufacturer that his prospective employee is little more than a senior student, and, in the absence of any statement to the contrary, there is some justification for regarding him as thoroughly competent not only to carry out the routine work of the factory, but also to undertake industrial research, to cheapen production, and to effect improvements in the manufacturing processes concerned. At the end of the year, in many cases, nothing very definite has resulted, no additional profit has been made, and there is no obvious improvement in the factory working, and the manufacturer is very apt to give emphatic expression to his disappointment, and to inveigh against science in general and chemistry in particular.

I wish it to be understood that my remarks apply especially to the general works chemists, to whom is entrusted the testing of the raw materials and finished products, and the exercise of a general scientific supervision. With the more important question of industrial chemical research it is quite impossible to deal within the limits of an annual address. I would only say that chemists competent to initiate and to carry through to a successful issue the kind of investigations which are of importance to manufacturers are, comparatively speaking, few in number, and that the chemical investigator, like the poet, must be born. He may be shaped, but he certainly cannot be made, and it would save not a little disappointment if it were recognised more generally on the industrial side that men possessing all the special qualities of intellect and of character which go to make a successful chemical investigator are not very frequently combined in any one man, and that the chances of obtaining the services of such a man in a more or less haphazard way, and at a salary which would be rejected with scorn by many an artisan, are not very great.

Summarising the points on which I have briefly touched in this address, I would appeal for—

(1) Greater sympathy, freer intercourse, and closer co-operation between the two great branches of the chemical profession—the teachers and the practitioners.

(2) The establishment of chairs of analytical chemistry in our universities and colleges as a practical step towards securing the more adequate treatment of that important branch of our science.

(3) The more general provision in our universities and colleges of post-graduate facilities for acquiring a good general knowledge of certain subjects which form an indispensable part of the professional equipment of every technical chemist.

SCIENCE AND BRITISH TRADE.[1]

WE were appointed on July 13, 1915, to be a Sub-Committee to prepare and submit a Report showing what steps should be taken to secure the position, after the war, of firms who have undertaken industries in consequence of the Exchange meetings leading up to the British Industries Fair, held under the auspices of the Board of Trade.

The following were the branches of industry to which it appeared that our inquiries could most usefully be directed, having regard to our terms of reference:—(i) Paper manufacture; (ii) the printing trade (including colour printing); (iii) the stationery trade; (iv) the jewellers' and silversmiths' trade; (v) cutlery; (vi) fancy leather goods; (vii) glassware, including table glass, laboratory ware, and glass bottles; (viii) china and earthenware; (ix) toys; (x) electrical apparatus; (xi) brush, etc., trade; (xii) hardware.

The value of the imports into the United Kingdom of goods of the kinds included within the scope of our inquiry may be taken as approximately 16,000,000*l.*, and of this total nearly 7,700,000*l.* represented goods of German origin, and 500,000*l.* goods of Austro-Hungarian origin. But it has to be remembered that there is also a large German and Austro-Hungarian export of these classes of goods into other parts of the British Dominions. In the absence of strictly comparable statistics, no absolutely definite figures can be given, but we estimate that the total value of such goods imported into the five self-governing Dominions and India in 1913 cannot have been less than 3,000,000*l.* Austro-Hungarian competition is noteworthy only in the case of jewelry and glassware. As regards German competition in the branches of trade under review, it is limited, as a rule, to certain special lines of goods

[1] Abridged from the Report of a Sub-Committee of the Advisory Committee to the Board of Trade on Commercial Intelligence with respect to measures for securing the position, after the war, of certain branches of British industry. (London: Wyman and Sons, Ltd.) [Cd. 8181.] Price 2½*d.*

and does not extend to the whole range of articles included in the class; and in a number of cases the exports of United Kingdom manufactures included under the same general heading are larger than, or nearly as large as, the foreign imports. This is so as regards paper for printing and writing; printed paper hangings; stationery (other than paper); cutlery, china, and earthenware; telegraph and telephone apparatus; unenumerated electrical goods and apparatus; and electrical machinery. The only cases in which the values of the imports of foreign-made goods are largely in excess of those of the exports of United Kingdom manufactures included under the same general headings are—paper for packing and wrapping; jewelry; fancy leather manufactures; flint glass and manufactures thereof; toys and games; and magnetos, which have been practically a German monopoly.

We proceed to the consideration of the detailed representations as to the ways in which Government assistance might be given to the various branches of industry which have been under our examination.

The value of scientific research in industry and the desirability of Government assistance in the promotion thereof, was generally recognised both in the memoranda furnished to us and by the witnesses who appeared before us, though it was admitted that British manufacturers and workmen have not always shown themselves in the past sufficiently appreciative of the value of scientific investigation into industrial problems, or of technical training. In a number of cases reference was made to the valuable assistance given by technical institutions to German industry, and, though no very definite evidence on the point was adduced, we see no reason to doubt the validity of the opinions expressed. As regards the particular British industries with which we are now concerned, very valuable work is being done in respect of glass by the University of Sheffield and the Institute of Chemistry (by the latter body especially as regards chemical glassware and optical glass); in respect of hard porcelain, and china and earthenware generally, by the School of Pottery at Stoke-on-Trent, which is an interesting example of combined trade enterprise; and in respect of paper, by the Manchester Institute of Technology, which, however, though fully equipped, is stated to exercise only a local influence and not to be utilised by the trade generally. All these institutions are said to be handicapped by inadequate financial resources. The representatives of the paper-making industry expressed a strong desire for Government assistance towards scientific investigation as to substitutes for resin size and aniline dyes, and for paper-coating materials hitherto imported, and also in the manufacture of parchment, grease-proof and other special papers. In the case of the printing trade we were informed that much assistance could be given by research work in respect of colour-printing and the application of photography to printing and lithography, whilst as regards the Birmingham jewelry trade it was stated that research into certain metallurgical problems and into the production of semi-precious stones would be advantageous. The electrical industry, of course, provides a very wide field for scientific industrial research.

At an early stage of the inquiry our attention was directed to the fact that an extensive scheme of State-aid for industrial research had recently been established by a committee of the Privy Council, and is, we understand, to be carried out by that Department in close communication with the Board of Trade. We are informed that a strong advisory council has been appointed, and that a number of applications (including requests for assistance from the Sheffield University, the Institute of Chemistry, the Stoke Pottery School, and the British Electrical and Allied Manufacturers' Association) are already before that body, and that the first grants are being made. We were accordingly able to refer to the new council and the funds at its disposal those witnesses who expressed the desire for State assistance in this direction, and to point out to them that the council in its consideration of any applications for help to any particular trade would no doubt be largely influenced by the extent to which the trade had already shown or would show a disposition to help itself. The new scheme is necessarily experimental, but it is capable of much enlargement, and we have no doubt that if British manufacturers are ready to co-operate with the Government in this matter and to avail themselves of the facilities put at their disposal, the operation of the scheme will be of very great value to British industry.

The Electrical Trades' Association urged that a Government inquiry should be instituted into the desirability of adopting decimal coinage and the metric system, both for this country and in the Dominions. The use of the metric system is, of course, already permissible; as to any Government action beyond that we are aware that opinion is divided; and we content ourselves with recording the suggestions.

The representatives of the stationery, silversmiths', fancy leather goods, mechanical and other toys, glass and magneto industries all urged upon us that many manufacturers, in putting down plant and finding capital for lines of manufacture which hitherto had been mainly or entirely German or Austrian, either to supply the home deficiencies caused by the cutting-off of the foreign supplies or to endeavour to supplant German trade abroad, were reasonably entitled to expect that the Government would safeguard them from the effects of unrestricted foreign (especially German and Austrian) competition after the war, especially as their action had been undertaken with direct Government encouragement, and in some instances (notably chemical glassware and magnetos) had been of substantial service in the conduct of the war.

In this connection we desire to direct special attention to the case of magnetos. Briefly, the facts are that prior to the outbreak of the war the trade in magnetos, which are of great importance for all forms of motor-cars and aircraft, as well as for other purposes, was virtually monopolised by the Bosch Company of Stuttgart, a very powerful organisation with great resources. The result was that at the sudden commencement of the war there were no manufacturers in this country where the normal demand was about 5000 magnetos per week; since then it has substantially increased, especially for military and naval purposes. A number of British firms took up the manufacture, and with the assistance of Sheffield in respect of the production of magnet steel, they have succeeded in making magnetos which have passed the Government tests and are asserted to be as good as the Bosch products. The firms are receiving large Government contracts, and there seems to be no doubt that in this instance (which is specially important as being one of a "key" industry) a considerable British manufacture could be built up which *inter alia* would guard against a repetition of the serious difficulties caused in the early stages of the war by our dependence on foreign supplies. The one obstacle is the reluctance of the firms concerned to commit themselves to further capital outlay, and the unwillingness of outside capital to come to their assistance, unless assured of some security against the strenuous efforts which the powerful Bosch concern will undoubtedly make after the war to break down the new British enterprise.

The representatives of this industry asked that Government assistance might be afforded them in the

shape of (1) an undertaking that the Government Departments concerned in motor transport and the air services would undertake to make use only of British magnetos made (so far as practicable) only of British parts—such undertaking to be for a term of years after the conclusion of the war; and (2) the extension to all magnetos of the import duty of $33\frac{1}{3}$ per cent. imposed upon magnetos imported as parts of motor-cars. We reported to the President of the Board of Trade that, in view of the importance of the manufacture of magnetos for military and naval purposes, its position as a "key industry," the efforts which the manufacturers have made, and the undoubtedly severe competition from the powerful Bosch interests which they will have to encounter after the war, we were unanimously of opinion that Government assistance might be given in the two forms desired by the industry.

Apart from proposals for the imposition of import duties on foreign goods, other suggestions put before us for the protection of British manufactures in other ways included the restriction of British Government contracts to British goods, or a preference to such goods in respect of price. The reasonableness of this claim was strongly urged upon us by representatives of the new magneto industry, and also in the case of table glassware. In this connection we were informed that at the instance of the British Science Guild a large number of educational institutions and authorities have already undertaken not to purchase any chemical glassware of foreign manufacture for a period of three years after the war, provided that an adequate supply of British manufacture is forthcoming.

RECOMMENDATIONS.

Scientific Industrial Research and Training.—(*a*) Larger funds should be placed at the disposal of the new Committee of the Privy Council, and also of the Board of Education, for the promotion of scientific and industrial research and training.

(*b*) The universities should be encouraged to maintain and extend research work devoted to the needs of the main industry or industries located in their respective districts; and the manufacturers engaged in those industries should be encouraged to co-operate with the universities in such work, either through their existing trade associations or through associations specially formed for the purpose. Such associations should bring to the knowledge of the universities the difficulties and needs of the industries, and give financial and other assistance in addition to that afforded by the State.

In the case of non-localised industries, trade associations should be advised to seek, in respect of centres for research, the guidance of the Advisory Council of the Committee of Privy Council for Scientific and Industrial Research.

(*c*) An authoritative record of consultant men of science, chemists, and engineers, and of persons engaged in industrial research, should be established and maintained by some suitable Government Department, for the use of manufacturers only.

Copyright.—The United Kingdom copyright law should be brought into line with that of the United States.

Patents.—(*a*) The efforts which have been made to secure uniformity of Patent Law throughout the Empire should be continued. (*b*) The provisions of the law as to the compulsory working of patents in the United Kingdom should be more rigorously enforced, and inspectors should be appointed to secure that such working is complete and not (as has frequently been the case) only partial. (*c*) The fullest possible information as to enemy patents should be given to British firms during the war, and every practicable assistance for their use.

Trade Marks.—All German and Austrian goods imported into the United Kingdom should be required to be marked with an indelible mark, "Made in Germany" or "Made in Austria-Hungary," and goods imported from other foreign countries should be similarly marked either with the country of origin or with the words "Foreign Made" or "Not British." Such marking should be in all cases on the actual goods and not merely on the package.

Transport.—A definite policy for the improvement and extension of the canal system of the United Kingdom should be formulated, with a view to its being carried out so soon as the national finances shall permit.

Financial Assistance.—(*a*) The joint stock banks should be invited by his Majesty's Government, so soon as opportunity offers, to consider the possibility of affording a greater measure of assistance to British industrial enterprise. (*b*) All Government Departments, local authorities, and statutory bodies entrusted with the control of moneys raised by taxes or rates, should be under legal obligation to purchase, so far as possible, only goods produced within the British Empire.

Trade Exhibitions.—The following broad principles should be adopted in respect of future trade exhibitions:—(*a*) Trade exhibitions should be held under the control of the Board of Trade; (*b*) exhibitions should be exhibitions of manufacturers' wares for traders, and should not be organised with the view of attracting the general public; (*c*) exhibitions should not be too general in scope, but should be for a limited number of branches of industry at a time, according to the importance and dimensions of each particular industry in this country; (*d*) at least one year's notice of the intention to hold any particular exhibition should be given to manufacturers.

Establishment of a Ministry of Commerce.—His Majesty's Government should be urged to consider anew the advisability of establishing a separate Ministry charged solely with the safeguarding and extension of British industry and trade, and freed from the regulative duties in respect of railways, shipping, and harbours, and the duties in respect of labour, which at present devolve upon the Board of Trade.

Extension of the System of Trade Commissioners.—The appointment of Trade Commissioners, responsible, and reporting directly, to the Board of Trade, should be extended to the principal foreign countries.

The Consular Service.—The organisation of the Consular Service should be dealt with so soon as possible after the completion of the report of the Royal Commission on the Civil Service, with a view to the increase of its commercial utility.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

ABERDEEN.—At the recent meeting of the University Court, intimation was received of a munificent benefaction to the University by Sir Alexander McRobert, Cawnpore, India, and of Douneside Lodge, Tarland, Aberdeenshire. Ten years ago Sir Alexander instituted a research fellowship in the University for the purpose of encouraging the investigation of the cause, prevention, and treatment of cancer. An annual sum was placed at the disposal of the University to meet the salary of the fellow and necessary working expenses. The fellowship has been held in succession by Drs. Bertie R. G. Russell, Alex. Greig Anderson, and Harold A. Haig, and some important investigations

have been carried out by them on the nature of cancerous growths. Sir Alexander McRobert has now placed the foundation on a permanent footing by handing over securities to the University which will yield an annual return of about 750*l.* It has been arranged that the foundation shall take the form of a lectureship, attached to the department of pathology. The lecturer will conduct research with a view to the elucidation of the problems of cancerous and other malignant diseases, and will also give instruction on subjects connected with his investigations.

SHEFFIELD.—The council, at its meeting on February 7, appointed Dr. A. J. Hall (senior physician, Sheffield Royal Hospital) to the professorship of medicine, in succession to Dr. D. Burgess.

A NOTE in the *Sunday Times* records that on February 4 Lord Hardinge, the Viceroy of India, laid the foundation-stone of the new Hindu University buildings to be erected at Benares. The estimated cost will amount to about 2,000,000*l.*

THE following appointments have been made in connection with the Royal College of Physicians of London:—Sir Thomas Barlow to be the Harveian orator for the present year, Dr. H. W. G. Mackenzie the Bradshaw lecturer, and Dr. W. J. Howarth to be the Milroy lecturer for 1917.

IT was stated in the manifesto issued last week on the position of science (see p. 640) that communications to the Reorganisation Committee should be addressed to 107 Piccadilly, London, which is the address of the Savile Club. The secretary of the Reorganisation Committee now asks that such communications should be addressed to him at 11 Airlie Gardens, London, W.

THE Government of Madras has inaugurated a scheme of lectures for the education of villagers in sanitary principles. Model lectures on various subjects affecting the daily life of the villagers have been prepared by the Sanitary Commissioner, and the idea is, we learn from the *Pioneer Mail,* to translate these lectures into the principal vernaculars of the Presidency in language easily understood by the people, and to get them delivered to villagers through the agency of the sanitary and educational staff, surgeons, and other competent persons, who may have sufficient interest in the movement.

IN addition to the war work being done in the departments of physics and arts and crafts of the Reading University College, to which reference was made in our recent note on the December issue of the *Reading University College Review,* we learn that the chemical department of the college is active in a similar direction. The work consists in the preparation of synthetic drugs for the Admiralty, and in connection with the Royal Society's Sectional Chemical Committee. Several old students have obtained temporary posts as chemists in explosive works, and a number are on the waiting list of the National Physical Laboratory for assisting in physical and engineering experiments upon war problems.

THE following gifts to higher education in the United States are announced in the issues of *Science* for December 31 and January 7 last:—A gift of 15,000*l.* to the Harvard Medical School; this is the balance of the bequest of Morrill Wyman, who established the Morrill Wyman Medical Research Fund, the income of which is to be applied in promoting investigation concerning the origin, results, prevention, and treatment of disease. Dr. Rudolph A. Witthaus, known for his work in chemistry and toxicology, who died on December 19 last, left most of his estate of more than 30,000*l.* to the New York Academy of Medicine. Dr. Witthaus left to the Academy of Medicine all his books and the estate for the benefit of the library. Grinnell College has received 10,000*l.* from an anonymous donor. The college is conducting a campaign for new endowment and buildings. Recently a parcel of land in Kansas City, valued at 30,000*l.*, was turned over to the college. The alumni of the college are raising funds for new buildings, the construction of which will be commenced next spring, which will cost about 50,000*l.* It is now said that the estate left by the late Mr. Amos R. Eno is likely to amount to 3,000,000*l.* Provided the will filed for probate last October stands, in the face of the contest being made by Mr. Eno's next of kin, Columbia University's share of the estate will be about 1,400,000*l.*

FURTHER gifts to higher education in the United States are recorded in the issue of *Science* for January 21. Mr. George T. Baker has made a further gift of 10,000*l.* to Cornell University; Barnard College, Columbia University, has received 20,000*l.* from Mr. James Talcott; a new chair at the University of Pennsylvania, to be known as the Dr. Isaac Ott chair in physiology, has been endowed through the legacy received from the estate of the late Dr. Isaac Ott; and the sum of 50,000*l.* has been given by Mrs. Russell Sage to the Emma Willard School in Troy to found a department of domestic and industrial art. The new department will occupy the buildings recently vacated by the school on the completion of new buildings made possible by a gift of 200,000*l.* from Mrs. Sage in 1907.

THE Department of Agriculture and Technical Instruction for Ireland has issued a circular (Form S. 125) giving particulars of the technical school examinations it will hold during the present year. The Department's scheme of examinations is designed to follow courses of instruction extending over four years in commerce, building trades' work, applied chemistry, electrical engineering, mechanical engineering, domestic economy, and art. Examinations in all subjects of the courses will be held this year in May. Certificates will not be issued by the Department in respect of the first and second years' examinations of any course, but pass lists will be issued to the local school authorities. It is intended that the courses of instruction of which these examinations will provide a test should include not only theoretical, but also practical and laboratory work.

NOTICE has been given that the fourth election to Beit fellowships for scientific research will take place on or about July 15 next. Not more than three fellowships will be awarded. Applications must be received on or before April 15. Forms of application and all information may be obtained, by letter only, addressed to the Rector, Imperial College, South Kensington, London, S.W. The annual value of every fellowship is 150*l.*, and its tenure is for one year, which may be extended by the trustees for a further period not exceeding one year. So long as the fellow is a graduate of a British University, or holds some approved diploma, he may be of any nationality provided he is of European descent by both parents. Every candidate must be under the age of twenty-five years on the date of election. Fellows are attached to a department of the Imperial College of Science and Technology, and work under the supervision of a professor in accordance with the arrangements made by the head of the department.

THE returns of the registration of students for November, 1915, of thirty of the universities in the United States are tabulated and analysed in an article by Mr. J. C. Burg, of Northwestern University, in the issue of *Science* for January 21. The largest gains in

the number of students, including the summer attendance, were registered by the following universities (the number in brackets giving the increase in the number of students):—California (2375), Pennsylvania (900), Minnesota (892), Chicago (837). The University of California, with a total of 10,555 students, was the only institution with a gain of more than 1000 students. Omitting summer students, the largest gains for 1915 are those of Pennsylvania and Minnesota. Four universities enrolled more than 7000 students, viz., Columbia (11,888), California (10,555), Chicago (7968), and Pennsylvania (7404). The article also provides some interesting statistics as to the number of students taking different branches of study. In engineering Michigan now leads with 1498 students, followed by Cornell with 1347. The largest medical school is at New York University, where 509 students are now enrolled. The school of commerce of New York University has 2639 students, and Pennsylvania comes next with 1889. The school of education at Columbia numbers 1972 students, as compared with 897 at Pittsburgh. These figures as to subjects are exclusive of summer students. The largest summer session in 1915 was at Columbia, where 5961 students were enrolled. At California a remarkable increase last summer of 2012 brought the number of summer students to 5364.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 3.—Sir J. J. Thomson, president, in the chair.—Prof. W. **Bateson** and C. **Pellew**: Note on an orderly dissimilarity in inheritance from different parts of a plant. In a recent paper the authors gave evidence as to the genetics of the wild-looking "rogues" which appear as the offspring of high-class types of peas. Among other peculiarities, it was shown that F_1 plants resulting from crosses between rogues and types were in their juvenile condition intermediate, showing influence of the type parent, but on maturing they become rogues and have exclusively rogue offspring. The authors interpreted this to mean that the type-elements are left behind in the basal parts of the plant. In the variety Gradus certain intermediates (offspring of types) were observed to give mixtures of types and rogues. In such intermediate plants the characters often change with age, the lower parts being more type-like, the upper more rogue-like. Preliminary sowings of seed from these intermediates indicate that when their offspring consists of types and rogues, *the types come predominantly from the lower pods and the rogues from the upper pods*. The three sets of facts are therefore consistent in indicating that there is an orderly segregation in the body of the plant, the type-elements being predominantly in the lower parts.—H. M. **Woodcock**: Observations on Coprozoic flagellates, together with a suggestion as to the significance of the kineto-nucleus in the Binucleata. The paper deals with the first results of a comprehensive study of the *coprozoic* flagellates of goats and sheep. The coprozoic fauna comprises those forms which pass through the alimentary tract in a resting, encysted state, and undergo all the active phases of their life-cycle in the (moist) dung.—S. B. **Schryver**: Investigations dealing with the phenomena of clot formations. Part III.—Further investigations of the cholate gel. It is shown that there is a marked similarity between certain vital activities of cells and the behaviour of cholate gel. (1) The erosive action of certain organic substances on the cholate gel runs parallel with their narcotic and cytolytic actions. (2) Gel formation by calcium chloride is inhibited by sodium, magnesium, and other chlorides. The same substances can also cause gel erosion, but the erosive action can be antagonised by the addition of relatively small amounts of calcium salts. (3) To explain the parallelism between certain biological actions of organic substances and the antagonistic action of inorganic salts, on one hand, and the action of these substances on the cholate gel, on the other, it is suggested that the cell membrane or cytoplasm is constituted by a heterogeneous system of lipoids, proteins, etc., held together in a magma containing a gel-forming substance with physical properties similar to those of the cholates. On such a hypothesis, the biological action of certain substances can be explained in a manner more satisfactory than is possible by the assumption of the "lipoid" theory of Hans Meyer and Overton.—J. M. **O'Connor**: The mechanism of chemical temperature regulation. Anæsthetised cats or rabbits, when not shivering, consume oxygen in proportion to their body temperature. When shivering, more oxygen is consumed than would otherwise be consumed at that body temperature. The onset of shivering is dependent on the brain temperature being below a point more or less fixed in a given animal. The amount of "extra oxygen" consumed during shivering is proportional to the extent to which the average skin temperature is below this point. This point towards which the animals regulate chemically varies in different animals between 30° and 39° C.

Mathematical Society, January 13.—Sir Joseph Larmor, president, and later Prof. A. E. H. Love, vice-president, in the chair.—Sir J. **Larmor**: The transition from vapour to liquid when the range of the molecular attraction is sensible. In the theory of capillarity, and of change of state, the hydrostatic pressure p is defined, in physical illustration, as the difference between two much larger quantities, the repulsion ϖ due to molecular motion, and the mutual attraction P of the molecules. Its graph, in the Andrews-Thomson diagram, determines the critical point and the conditions for change of state. It is a definite quantity only where the density is unform; thus it loses its meaning inside interfacial layers of rapid transition, though under fluid conditions it is transmitted across such layers. The instability in homogeneous fluid, and consequent separation of phases, which ensues when dp/dv becomes positive, is essentially a matter of the internal constitution of the fluid, and ought to be so deducible. It is found, however, that the homogeneous medium is unstable for variation of density when $d(p-P)/dv$ is positive: whereas instability from external stress, when the density is not disturbed, occurs within the narrower limits for which dp/dv is positive. When the range of attractions is sensible there will thus be arcs of internal instability along the isothermals above the critical point, for which, however, separation into two phases, vapour and liquid, cannot occur. It might be imagined as relieved by gradual falling away of the medium to modified states of molecular aggregation; and, in fact, the question arises, why this type of change should be regarded as excluded in the usual theory, notwithstanding the aptness of the van der Waals equation. An S-shaped convolution of the isothermal is still the condition for abrupt transition of state. Other conditions restricting the form of such law of attraction as is compatible with the existence of a homogeneous phase are noticed.—T. W. **Chaundy**: (1) A note on the uniform convergence of the series $\sum a_n \sin n\theta$. (2) A condition for the validity of Taylor's expansion.—G. H. **Hardy**: The average order of the arithmetical functions $P\Delta(x)$.—(x) and C. E. **Weatherburn**: Green's dyadics in the theory of elasticity.—G. N. **Watson**: A problem in "Analysis Situs."

Geological Society, January 19.—Dr. A. Smith Woodward, president, in the chair.—H. **Bury**: The physical geography of Bournemouth. The curves of the plateaux in the Hampshire basin (including that of Bournemouth) show a marked relation to the main river-valleys, indicating that the latter were in existence before the plateau-gravel was deposited. The fact that this gravel everywhere covers the main watersheds is inconsistent with the theory of deposition on simple river-terraces, and points to widespread floods and the formation of gravel-sheets at one or more periods. Palæoliths are most frequent at low levels (below 140 ft. O.D.), but occur up to 350 ft. O.D., where their presence must be due either to a vast accumulation of gravel in Chellean times, or to channelling at later dates. The Chines along the coast of Bournemouth Bay did not originate at the cliff-edge and grow inland, but are the over-deepened bottoms of older and longer valleys. A similar double structure is seen in the Chines of the south-western corner of the Isle of Wight, where it is due to the destruction of part of the valley of the Yar by the sea since the deposition of the valley-gravel; and it is suggested that the Bournemouth Chines are due to the breach of the Solent River by the sea at the same late period. The 140-ft. bluff, running all across Hampshire to the sea-cliff at Goodwood, is comparable with the 100-ft. terrace of the Thames, and was probably formed in an estuary in pre-Chellean times. The rate of recession of the cliff in the western part of Bournemouth Bay is estimated at about 1 ft. per annum. It may be more in the eastern part. The angle of the cliffs is said to have become steeper of late years; but this is not true of the western part of the bay, and it is desirable that the observations on which the belief rests should be published.

Linnean Society, January 20.—Prof. E. B. Poulton, president, in the chair.—Miller **Christy**: The definition of "right" and "left" in relation to coiled, rolled, revolving, and similar objects: a problem in scientific terminology. The author referred to such terms as "right" and "left," following or against the sun (in northern latitudes), "clock-wise" and "counter clock-wise," as used by biologists, and also cited terms used by mathematicians which could not be used by naturalists with any advantage. He advocated the usage postulated by Linnæus, in his "Philosophia botanica," p. 103, before he became confused and altered his definition to an absurdity, and recommended the use of the heraldic terms "dextral" and "sinistral" as unambiguous terms.—H. W. **Monckton**: Some aspects of the flora of the Bagshot district. This communication deals with the area occupied by the geological formation known as "The Main Mass of the Bagshot Sands." About half is in Surrey, the remainder being nearly equally divided between Berkshire and Hampshire. The greater part was until recent times a tract of pine-woods, heaths, and peaty swamps, and its character was mainly due to the sandy nature of the Bagshot formation and the gravels resting upon it. The flora of much of the area resembles that of the Oak-Birch-Heath Association ("Types of Brit. Vegetation," ed. by A. G. Tansley, Cambridge, 1911, p. 101). Other parts fit in well with the Heath Association, *op. cit.*, p. 105. Much of the high ground forms plateaux covered with gravel some 10 to 15 ft. thick, and on it are found the usual heath-plants. *Illecebrum verticillatum* is perhaps the most interesting plant found in the district.

MANCHESTER.

Literary and Philosophical Society, January 25.—Prof. S. J. Hickson, president, in the chair.—Dr. H. F. **Coward** and F. **Bailey**: Causes of luminosity in coal-gas flames. A stream of coal-gas was passed through a tube immersed in solid carbonic acid and ether, at $-79°$ C. This condensed completely all the benzene, toluene, and similar substances, but allowed the whole of the ethylene to pass forward with the gas. The luminosity of the flame of the issuing gas was very feeble in comparison with that of the original gas. Measurements carried out by Mr. W. Buckley at the Corporation Gas Works, Rochdale Road, Manchester, showed that a particular coal-gas lost 78 per cent. of its illuminating power by this treatment. The benzene hydrocarbons therefore contribute far more to the luminosity of coal-gas flames than does ethylene, in spite of the fact that the volume of ethylene present is usually three to five times the volume of benzene vapour.—Prof. S. J. **Hickson**, Dr. W. M. **Tattersall**, and others: Animal symmetry and the differentiation of species.

EDINBURGH.

Royal Society, January 24.—Dr. Horne, president, in the chair.—Dr. J. E. **Mackenzie** and Dr. **Ghosh**: The optical rotation and cryoscopic behaviour of sugars dissolved in (*a*) formamide, (*b*) water. To previous results already published the authors have added experiments for β-*d*-glucose, β-*d*-galactose, and maltose. As in the case of the water solutions of these sugars, the constant rotation shown when there is equilibrium between the two multiplications is found to be the same whether the starting point be the α or the β modification. The phenomena are of the same nature in non-aqueous and aqueous solutions. Any explanation of mutarotation reactions must account for such actions taking place in the absence of water.—Dr. **Ghosh**: Note on the sublimation of sugars. It was shown that under diminished pressure rhamnose and fructose sublime. Up to this time the only sugar which had been observed to sublime was glycolose.—W. **Collinge**: A revision of British Idoteïdæ, a family of marine Isopoda. The object was to revise the diagnoses of the British genera and species, and set forth, in greater detail than has hitherto been done, their structure and the classification and affinities of the family. The investigation was carried out in the Gatty Marine Laboratory of St. Andrews University.

DUBLIN.

Royal Dublin Society, January 25.—Prof. J. A. McClelland in the chair.—Prof. Hugh **Ryan** and T. **Dillon**: The hydrocarbons of beeswax. Inconsistencies in the results obtained in the analysis of beeswax led to an examination of the action of potash-lime on alcohols. The volume of hydrogen evolved by the interaction of higher primary alcohols and potash-lime is nearly but not quite in accordance with the equation:—

$$C_nH_{2n+1}\,CH_2OH + KOH = C_nH_{2n+1}\,COOK + 2H_2.$$

Higher secondary and tertiary alcohols, such as pentadecyl-*p*-tolyl carbinol and heptadecyldimethyl carbinol do not evolve hydrogen when heated to 250° C. with potash-lime, and similarly the volume of hydrogen evolved by the action of alkali on glucose corresponds very nearly to the one primary alcoholic group in the sugar. The solids extracted by petroleum ether from the product of the action of potash-lime on myricin contain a small percentage of oxygen, and for this, as well as other reasons, the "potash-lime method" of determining hydrocarbons in beeswax yields results which are too high.—Prof. Hugh **Ryan** and M. J. **Walsh**: Desoxyhydrocatechintetramethyl ether. The chromane formula for catechin proposed by A. G. Perkin and Yoshitake exhibits the genetic relations of the phlobatannins, the flavone, and the anthocyan dyes, much more clearly than the coumarane

formula of S. von Kostanecki and V. Lampe, although the latter formula accords better with the chemical behaviour of catechin.

Royal Irish Academy, January 24.—Rev. J. P. Mahaffy, president, in the chair.—Prof. J. A. **McClelland** and Rev. R. **FitzGerald**: The photo-electric properties of leaves. The paper deals with the photo-electric power of leaves and gives numbers for leaves of various types. It also deals with the extraction of chlorophyll from leaves and the activity of the solutions thus obtained. It is also shown that distilled water in which leaves have been immersed has considerable photo-electric activity. The concluding portion of the paper deals with the increase of photo-electric power produced by the action of oxidising agents on the water extracts and on certain organic substances.

PARIS.

Academy of Sciences, January 17.—M. Camille Jordan in the chair.—Gaston **Darboux**: An extension of Poncelet's theorems relating to polygons inscribed or circumscribed about conics.—Armand **Gautier** and Paul **Clausmann**: Fluorine in the vegetable kingdom. A table is given of the quantities of fluorine and phosphorus in various parts of the plant. In the choice of material special attention has been paid to substances utilised as food for men and animals. In plants the leaves are the organs richest in fluorine, the smallest quantities being present in stem, wood, and bark. The ratio of phosphorus to fluorine in the different organs of the plant follows no simple relation, but, as in animals, the two elements increase and decrease together.—Henri **Douvillé**: The Cosmoceratideæ; the history of a family of Ammonites, from a posthumous memoir of Robert Douvillé.—Ch. **Platrier**: The solutions of certain linear integral equations of the third species considered as limits of equations of the second species.—M. **Angelesco**: A class of polynomials with a single variable.—J. **Priwaloff**: The convergence of conjugate trigonometrical series.—Amé **Pictet** and Tsan Quo **Chou**: The formation of pyridine and *iso*quinoline bases starting from casein. Casein was hydrolysed by hydrochloric acid in presence of formaldehyde (added gradually as methylal), the product dried and distilled with lime. The mixture of bases obtained, amounting to 9 per cent. of the original casein, was freed from primary and secondary bases by treatment with sodium nitrite. From the residual tertiary bases pyridine, *iso*quinoline, and homologues of these were isolated. None of these bases were obtained if formaldehyde is not present during the hydrolysis of the casein.—S. **Reich**: The nitration of phenylpropiolic acid. Under suitable conditions *para-* and *ortho*-nitrophenylpropiolic acids can be obtained by direct nitration. No *meta* acid could be isolated.—G. **Friedel**: The observations of Hoga and Jaeger relating to certain lack of symmetry of crystal radiograms. A discussion of the possibility of these results being due to a slight imperfection in the orientation of the crystal plate. An error of 1° or 2° would suffice to produce all the phenomena described.—G. **André**: The displacement of potash and phosphoric acid contained in certain rocks by some substances employed as manures. Finely powdered minerals containing potash yield appreciable amounts of potash to water alone, and this amount is markedly increased if certain substances present in manures are added. Chalk, salt, and calcium sulphate produce about the same effect; sodium nitrate, and especially ammonium sulphate, cause larger amounts of potash to go into solution. The results of similar experiments on the extraction of soluble phosphate from apatite are also given.—H. **Bouygves**: The culture of the sugar-beet in the south-west of France. The yield per hectare has been found to be somewhat larger in the south (Lot, Lot-et-Garonne, Gironde, and Dordogne) than in the north, and the yield of sugar is not inferior.—M. **Bassuet**: The treatment of old wounds arising from the war. A contribution to the discussion of the hypothesis of micro-organisms remaining latent in old, and apparently healed, wounds. On treating open wounds of long standing by a polyvalent serum, either by injection or by simple local dressings, many cases have been observed of the formation of an abscess rich in pus at a distance from the point of injection or treated wound; but always forming under the scar of an old healed wound. Frequently (thirty-one cases out of forty-nine) fragments of clothes, splinters of bone, pieces of projectile, and, in one case, a drainage tube 7 cm. long, have been eliminated by the abscess. The local cure takes place rapidly, and coincides with a marked improvement in the general state of the patient. Out of 421 cases, after treatment without being cured during periods of eight to fourteeen months in various hospitals, 282 have been discharged cured.—L. G. **Seurat**: The morphology and phylogeny of the Acuaridæ.

CALCUTTA.

Asiatic Society of Bengal, January 5.—W. H. **Phelps**: Some Calcutta spiders. Among the points dealt with were:—*Cyrtophora citricola*: Their individuality, variety of characteristics, individual markings, industry and skill, elaborate snares, adaptability to artificial light, notwithstanding their home is in the garden or the jungle, nesting and snare building, aviating, skin casting, etc. *Spariolenus tigris*: A detailed description was given of nest building, the laying of eggs, the development of the egg into the young spider, with a time-table.—M. S. **Ramaswami**: A new species of Tephrosia from Sind. In this paper a hitherto unknown species of Tephrosia (family Papilionaceæ) with curious falcate or circinnate pods is described in Latin and in English. The distribution of this new plant is Sind and Rajputana. A plate with figures of parts of the plant, including floral dissections, is appended.

BOOKS RECEIVED.

Manuals of Chemical Technology. v., Sulphuric Acid and Sulphur Products. By Dr. G. Martin and Major J. L. Foucar. Pp. viii+77. (London: Crosby Lockwood and Son.) 7*s*. 6*d*. net.

A Text-Book of Geology. By Profs. L. V. Pirsson and C. Schuchert. Part ii., Historical Geology. By Prof. C. Schuchert. Pp. vi+405–1026. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 12*s*. net.

A Meteorological Treatise on the Circulation and Radiation in the Atmospheres of the Earth and of the Sun. By Prof. F. H. Bigelow. Pp. xi+431. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 21*s*. net.

Graphics and Structural Design. By Prof. H. D. Hess. Second edition. Pp. viii+435. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 12*s*. 6*d*. net.

Third Appendix to the Sixth Edition of Dana's System of Mineralogy (completing the Work to 1915). By Prof. W. E. Ford. Pp. xiii+87. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 6*s*. 6*d*. net.

The London Matriculation Directory. January. (London: University Tutorial Press, Ltd.) 1*s*. net.

Annals of the Solar Physics Observatory, Cambridge. Vol. iii., part 1, August. The Solar Rotation in June, 1911, from Spectrographic Observations made with

the McClean Solar Instruments. By J. B. Hubrecht. Pp. 77. (Cambridge: At the University Press.) 9s. net.

Heaton's Annual. Twelfth Year. Pp. 463. (Toronto: Heaton's Agency.) 5s.

Canada. Department of Mines. Geological Survey. Memoir 80. Huron and Wyandot Mythology. By C. M. Barbeau. Pp. xiv+415+xi plates. (Ottawa: Government Printing Bureau.)

The Theory of Abstract Ethics. By T. Whittaker. Pp. viii+126. (Cambridge: At the University Press.) 4s. 6d. net.

An Introductory Course of Practical Magnetism and Electricity. By Dr. J. R. Ashworth. Third edition. Pp. xvii+96. (London: Whittaker and Co.) 2s. net.

The Journal of the Institute of Metals. Vol. xiv., No. 2. Pp. ix+289. (London: Institute of Metals.) 21s. net.

Forty-fourth Annual Report of the Local Government Board, 1914–15. Supplement containing the Report of the Medical Officer for 1914–15. Pp. xxxiv+100. (London: H.M.S.O.; Wyman and Sons, Ltd.) 6½d.

Proceedings of the Liverpool Geological Society. Cape Memorial Volume: On the Igneous and Pyroclastic Rocks of the Berwyn Hills (North Wales). By the late T. H. Cope. Pp. 115. (Liverpool: C. Tinling and Co., Ltd.)

Ray Society. The British Marine Annelids. Vol. iii., part ii. Plates. Polychæta—Opheliidæ to Ammocharidæ. By Prof. W. C. McIntosh. Plates lxxxviii–cxi. (London: Dulau and Co., Ltd.) 25s. net.

Memoirs of the Indian Museum. Vol v., No. 3, December. Fauna of the Chilka Lake. Crustacea Decapoda. By S. Kemp. Pp. 199–325. (Calcutta: Indian Museum.) 9 rupees.

Board of Education. Examinations in Science and Technology, 1915. Examination Papers and Reports of Examiners. Pp. 140. (London: H.M.S.O.; Wyman and Sons, Ltd.) 9d.

A Critical Revision of the Genus Eucalyptus. By J. H. Maiden. Vol. iii., part 4. Pp. 63–79. (Sydney: W. A. Gullick.) 2s. 6d.

DIARY OF SOCIETIES.

THURSDAY FEBRUARY 10.

ROYAL SOCIETY, at 4.30.—The Theory of the Helmholtz Resonator: Lord Rayleigh.—The Oxyhydrogen Flame Spectrum of Iron: Sir N. Lockyer and H. E. Goodson.—The Consumption of Carbon in the Electric Arc. III. The Anode Loss: W. G. Duffield and M. D. Waller.—Surface Friction. Experiments with Steam and Water in Pipes: C. H. Lander.—The Structure of Broadened Spectrum Lines: T. R. Merton.

ROYAL INSTITUTION, at 3.—Measurement of the Brightness of Stars; Visual and Photographic Magnitudes: Sir F. W. Dyson.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Testing of Underground Cables with Continuous Current: O. L. Record.

OPTICAL SOCIETY, at 8.—Optical or Visual Signalling: Dr. W. J. Ettles.

MATHEMATICAL SOCIETY, at 5.30.—(1) Theorems on Straight Lines Intersecting at Right Angles; (2) The Classification of Rational Approximations: J. H. Grace.—Infinite Derivates: Mrs. G. C. Young.—The Bilinear Curvature and other Functions of Independent Directions on a Surface: E. H. Neville.—The Attraction of Equiangular Spirals: Dr. Brodetsky.

FRIDAY, FEBRUARY 11.

ROYAL INSTITUTION, at 5.30.—Egyptian Jewelry: Prof. W. M. Flinders Petrie.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Annual General Meeting.

PHYSICAL SOCIETY, at 5.—A General Bridge Method for Comparing the Mutual Inductance between Two Coils with the Self Inductance of one of them: Prof. C. H. Lees.—An Enclosed Cadmium-Vapour Arc Lamp: Dr. H. J. S. Sand, D.Sc.

MONDAY, FEBRUARY 14.

ROYAL SOCIETY OF ARTS, at 4.30.—Flemish Architecture: Rev. Dr. H. West.

TUESDAY, FEBRUARY 15.

ROYAL INSTITUTION, at 3.—Nerve Tone and Posture: Prof. C. S. Sherrington.

ROYAL STATISTICAL SOCIETY, at 5.15.

INSTITUTION OF PETROLEUM TECHNOLOGISTS, at 8.—Oil Shales, especially those of Dorsetshire: W. Hardy Manfield.

WEDNESDAY, FEBRUARY 16.

ROYAL SOCIETY OF ARTS, at 4.30. Women's Work During and After the War: The Hon. Lady Parsons.

ROYAL MICROSCOPICAL SOCIETY, at 8.—The Progress and Development of Vision and Definition under the Microscope: Messrs. Heron-Allen Earland, and Rousselet.—An Experiment with the Ultra-microscope: J. E. Barnard.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—The Rainfall of Nigeria and the Gold Coast: C. E. P. Brooks.—South African Coast Temperatures: Dr. J. R. Sutton.

THURSDAY, FEBRUARY 17.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* The Action of Cobra Venom: Prof. A. R. Cushny and S. Yagi.—Gametogenesis and Sex Determination in the Gall-fly, *Neuroterus lenticularis*. III.: L. Doncaster.—The Structure and Development of the Skull and Laryngeal Cartilages of Perameles, with Notes on the Cranial Nerves: Philippa C. Esdaile.—Physiological Investigations with Petiole-Pulvinus Preparation of Mimosa-Pudica: J. C. Bose and S. C. Das.

ROYAL INSTITUTION, at 3.—Variable Stars: Sir F. W. Dyson.

ROYAL GEOGRAPHICAL SOCIETY, at 5.—A Synthetic Method of Determining Geographical Regions: Dr. J. F. Unstead.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Kelvin Lecture: Terrestrial Magnetism: Dr. C. Chree.

ROYAL SOCIETY OF ARTS, at 4.30.—The Saints of Pandharpur: C. A. Kincaid, C.V.O.

LINNEAN SOCIETY, at 5.—John Bartram; the Pioneer American Botanist: Miss C. Herring-Browne.—Acorn Producing Twin Plants: Miss M. Rathbone.—Winter and Summer Coloration of the Ermine, *Putorius erminens*: E. S. Goodrich.—The Infestation of Bamboos in Tidal Waters by *Balanus amphitrite* and *Teredo navalis* in Tenasserim: E. P. Stebbing.

FRIDAY, FEBRUARY 18.

ROYAL INSTITUTION, at 5.30.—Polarised Light and its Application to Engineering: Prof. E. G. Coker.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Annual General Meeting.

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THURSDAY, FEBRUARY 17, 1916.

SCIENCE IN THE PUBLIC SCHOOLS AND THE CIVIL SERVICE.

FROM the welter of the billows which have recently beaten about the place of science in education, in the columns of the periodical Press, two main points stand out, namely, those of the dominance of classical and literary teaching in our great Public Schools, and its influence upon the older universities and the public Services. Our political leaders and administrators of State departments are in the main trained in these schools, where vested interests preserve the prime places in the curriculum for ancient learning, and scientific subjects are discouraged for students who hope to obtain university scholarships or appointments in the highest ranks of the Civil Service.

The position of affairs has been stated clearly in correspondence published in the *Observer* during the past few weeks, particularly with reference to the undue proportion of open scholarships allotted to classics at the older universities. There is no question as to the facts, but Dr. A. E. Shipley and Mr. H. A. Roberts attempt to justify, or rather to explain, them by standards of attainment. They point out that the award of scholarships depends upon the ability of the candidates presenting themselves, and assert that real ability is found much more rarely among those who offer scientific subjects than among the candidates who have selected classics. "No candidate," they say, "in natural science who reaches the necessary standard of ability is likely to be rejected. But the supply of candidates of sufficient ability is not so great as it should be."

This is especially true of candidates from the great Public Schools, and it is with this deplorable condition of things that we are at the moment most concerned. In a recent year, according to Dr. Shipley and Mr. Roberts, in one of the greatest of such schools, excellently equipped for scientific studies, less than 2 per cent. of the boys in the higher forms were giving special attention to science, and only one or two of these were of sufficient ability even to appear as competitors in any scholarship examination at the universities, so that "the contribution of this great school to the scientific ability of the country was less than one-fifth of 1 per cent. of the total numbers of the school."

We should have supposed that such facts as these would be sufficient to condemn the present system, and to induce advocates of reform to make the most strenuous efforts to alter it. The "Converted Classic," to whose remarks the letter by Dr. Shipley and Mr. Roberts was intended as a reply, asks pertinently why the universities thus submit to the dictation of the Public Schools as to the relative value of science and classics instead of themselves prescribing subjects, and by limiting the awards to classics to induce the headmasters to give adequate attention to science.

"The study of classics," he adds, "is a luxury, and should be treated as such; the study of science is a real and present necessity. Classical training tends to produce the official; scientific training tends to produce the man of initiative and action—the creator. Which of the two types is the more necessary at the present time? Let, then, higher education take the initiative; let the 'Varsities force the schools, for in their hands, to a great extent, lies the remedy."

It is not at all certain that the headmasters of the Public Schools would adopt a new attitude towards science even if the universities limited the number of classical scholarships in the manner suggested; for most of the pupils sent up are not scholarship candidates. The result of the action would, however, encourage the development of scientific work in the State secondary schools, and the end would be that these schools would secure the science scholarships, while as regards the current of modern needs the Public Schools would be in a backwater. They may be content to occupy that position, but there is no reason why a premium should be placed upon their unprogressive methods. What we have to get rid of is the idea, naïvely expressed by a correspondent in the *Westminster Gazette* a few days ago, that the classical studies of the ancient schools and universities should be reserved for men who are to occupy the highest branches of the public Services. The assumption that classical languages and literature are essential to the education of people who are to control our affairs, and that a knowledge of science is not needed in this capacity, is responsible for the chief defects which have to be remedied if we are to compete successfully in peace or war with other leading nations. A truer view is that no one should be entrusted with the administration of affairs of State who has not received a scientific education, and that classical learning should be considered as an intellectual hobby.

As things are at present, it pays far better to study classics than science, if a post of importance in the Civil Service is the proximate or ultimate end. The examinations for Clerkships (Class I.)

bear much the same relationship to the older universities that the universities bear to the Public Schools. Candidates for appointments in the Home and Indian Civil Services, and for Eastern Cadetships, are at liberty to select any of thirty-eight subjects, provided that the total number of marks carried by the subjects does not exceed six thousand. At least ten or twelve subjects must be taken, and a high standard reached in them, in order that a candidate may have a reasonable chance of success. The majority of the successful candidates select Greek and Latin, English history, language and literature, mental and moral science, and political economy. Occasionally, a brilliant mathematician will secure a good total of marks, but candidates who specialise in science rarely obtain a high place.

The considerations which determine largely the nature of the subjects selected are the relative number of marks obtainable and the attention given to different branches of study at the Public Schools and the older universities. Greek and Latin languages and literature have each eleven hundred marks, and five hundred each in addition for Greek and Roman history. The only subjects which compare with these as regards allocation of marks are included in the groups Lower and Higher Mathematics, each of which has a maximum of twelve hundred. Chemistry, physics, geology, botany, zoology, animal physiology, and geography carry six hundred marks each, but not more than four science subjects can be offered—the candidate who will present himself for examination in more should certainly not be encouraged—or three if both Lower and Higher Mathematics are taken.

A fairly high standard of attainment is thus required in four separate branches of science in order to hope for the same number of marks as can be obtained for a knowledge of Greek and Latin language and literature. This fact, and the predominance of classical studies and interests in the educational institutions most favoured by the wealthier classes, is responsible for the selection of subjects by candidates who present themselves for examination. At the examination held just before the war began there were 206 candidates for 78 appointments. Of those who were successful only four offered science subjects without mathematics or classics, and seventeen owed their position to marks from mathematics with science. Forty-five specialised in Greek and Latin, and the remainder presented themselves in other literary subjects, with or without mathematics.

This analysis is typical of results of examination for Clerkships (Class I.), and it shows that the great majority of the men appointed to the highest positions in the Civil Service, and by whom national affairs are to be administered, are specialists in classics without an elementary knowledge of science, and with no conception, therefore, of the meaning of scientific method. It follows almost naturally that nearly all the successful candidates are from the universities of Oxford and Cambridge, and especially from Oxford. It is possible that the Civil Service Commissioners believe that their system of marking gives an open field to all students—whether classical, scientific, or linguistic—but the result is the same as that from the selection of scholarship candidates, namely, the appointment of few men of scientific attainments; and the cause of it all is the neglect of science, and the predominance of classics, in the curriculum of the Public Schools.

In 1914 the Royal Commission on the Civil Service recommended the Government to appoint a committee with the object of ascertaining whether there is any substantial foundation for the view which certainly prevails that the scheme for examination for Class I. unduly favours the curricula of the older universities and handicaps those of the newer. It was suggested that, should it be found any change is desirable, the committee, while maintaining the high standard necessary for the examination, should revise and rearrange the syllabus, weighing the educational value of classical learning against those of modern and scientific studies. The committee has not, so far as we know, yet been appointed, and we are not very sanguine as to the effect of any changes which it might recommend, while the work of our Public Schools remains almost entirely in the hands of classical headmasters. They and the parents trained on the Chinese method seem to be incapable of understanding why the needs of the present day differ from those of past centuries.

Latin and Greek were first introduced into our schools as a means of acquiring new knowledge, and not because of their supposed formative influence upon character. When Augustine established the first grammar school in England, at the end of the sixth century, Latin was taught in order that the native priests, and converts of the upper classes, might understand the rudiments of the new religion. From that time to the Renaissance and onward, the learning of Latin was the whole aim and end of education in schools; because the language was the living tongue of scholars. For, as the late Mr. A. F. Leach points out in his "Schools of Medieval England," people wanted to

know Latin, not to write Latin verses in imitation of Vergil, but to speak it or to read the latest work on theology or tactics or geography. The introduction of Greek into the curriculum of schools came with the Renaissance, but was not, as is often suggested, responsible for the birth of the new learning. Greek was introduced into Winchester and Eton, New College and Magdalen, in the fifteenth century, because these schools and colleges were the advanced institutions of the day, and their scholars the leading humanists of their age, eager for new light. Humanism then meant the substitution of new teaching for old, and its followers aimed at moulding "the nature of man as a citizen, an active member of the State," rather than at continuing the studies of doctrines relating to the next world upon which the attention of educated mankind had been concentrated for a thousand years.

We want to see a like recognition of the need of scientific knowledge on the part of the humanists of to-day, in the place of that attitude of obscurantism which they present to it. We want to make science the keynote of our Public School and University system, as Humboldt and others did in Prussia at the beginning of the nineteenth century, when Germany was under the heel of Napoleon; for to it are due the position and power gained by that country since then. The lesson which the French learnt from their disaster in 1870 was that attention must be given to education at every stage, and more especially to higher education, in order to secure their position most effectively. Are we to await like defeat before taking the necessary steps to ensure that our legislators, governing officials, and others who exert the highest influence in the State receive the scientific education which modern life demands?

CATALYSIS.

Text-books of Chemical Research and Engineering. Catalysis and its Industrial Applications. By E. Jobling. Reprinted from *The Chemical World*. Pp. viii+120. (London: J. and A. Churchill, 1916.) Price 2*s*. 6*d*. net.

THIS little book consists of a series of articles originally contributed to *The Chemical World*, and deals with a class of phenomena which have attracted special attention of late years owing to their growing importance in many operations of chemical technology. The fact that certain chemical processes can be initiated or greatly accelerated by the presence of some foreign material which *apparently* remains unchanged was recognised in the early part of the last century and denoted by the term *catalysis*, first applied by Berzelius in 1835. One of the earliest facts which is brought to the knowledge of the chemical tyro is the influence of manganese dioxide in promoting the disengagement of oxygen from potassium chlorate, and if he ponders at all upon the circumstance one of his earliest impressions must be of the inadequacy or unsatisfactory nature of the explanation of the cause of the phenomenon. But as his knowledge increases he learns to recognise that the influence of extraneous substances in promoting chemical change is in reality a very common phenomenon. At the same time, comparatively little is known of the mechanism of these catalytic actions. In a few cases it has been definitely ascertained that the catalytic agent does experience a series of changes. During the course of a reaction it is being continually decomposed and recomposed, and by suitable means the presence of the intermediate product can be detected. Hence it is reasonable to suppose that all catalytic phenomena depend upon the alternate decomposition and recomposition of the catalytic agent. Another curious fact brought to light by the industrial application of catalysis is that the activity of a catalytic agent may be wholly inhibited by the presence of another foreign body or, in the language of the technologist, of a so-called *poison*.

In Mr. Jobling's book much that is known of a rapidly developing subject has been brought together and described in a clear and interesting manner. In an introductory chapter he deals with the purely scientific aspects of catalysis and the characteristics of catalytic reactions, autocatalysis, pseudo-catalysis, etc. The rest of the book is concerned with the industrial applications of catalytic agents, as, for example, in the manufacture of sulphuric acid by so-called contact processes; of chlorine and salt-cake by Deacon and Hasenclever's process and the methods of Hargreaves and Robinson; of sulphur recovery by the Claus-Chance and Gossage processes; of the fixation of atmospheric nitrogen by the Haber and Ostwald's processes, etc.; of surface actions as illustrated by the work of Bone and his co-workers on surface combustion; incandescent gas-mantles, etc.; of hydrogenation, the work of Sabatier and Senderens and its application to the "hardening" of oils—a phenomenon of the greatest practical utility. Lastly, we have two short chapters on dehydrogenation and oxidation; and on dehydration, hydrolysis, etc., interesting as serving to throw light upon a variety of complex reactions depending apparently upon catalytic agencies, and as suggesting their applications in technical processes.

The book deserves the serious attention of every student of chemistry. It will open his eyes to the boundless possibilities of a field of inquiry of which even the very fringes have only been very imperfectly explored as yet, but which, there is no doubt, is destined to yield fruit of the greatest richness and value.

THE STUDY OF VARIABLE STARS.

An Introduction to the Study of Variable Stars. By Dr. C. E. Furness. Pp. xx+327. (Boston and New York: Houghton Mifflin Co., 1915.) Price 1.75 dollars net.

IT has been said that it is more important to measure the light than the place of a star. Add the time factor and there is the observational province of the student of variable stars, namely, the measurement of the relationship between time and lustre of particular stars. The present book is largely given up to explaining methods by which this can be accomplished The author is one who has had almost unique opportunities fitting her to undertake the task, which might have been more successfully carried out had the aim been more ambitious. As director of Vassar College Observatory, Dr. Caroline Furness has not only actively engaged in variable star observation, but has also conducted the regular courses of study in this special subject in the astronomical department of the College. These occupations have ensured the necessary documentation and provided valuable experience in the practice of stellar observation, in the art of exposition, and especially in the needs of novices in this important branch of sidereal physics. The volume, it may here be mentioned, finds a place in the "Semicentennial Series" of works by distinguished alumni issued in commemoration of the fiftieth anniversary of the foundation of Vassar, and at present it stands alone in the English language.

The intention of the work is primarily to *make* observers, and the practical side of the subject is kept prominently to the fore throughout. The historical aspect, however, receives considerable attention, and much interesting material has been collected. With the first aim in view the author attempts to supply the reader with concise information on a range of preliminary subjects such as "Durchmusterung charts," "photometry in all its branches," "spectroscopy," "star colours," etc. These efforts lead to a tedious description of star maps and charts, a summary of the rudiments of spectrum analysis, a lengthy non-technical account of Nichol's prism, taken, it would seem, from a well-known English text-book of physics, and, among other things, to the inclusion of an abstract of a paper on the physiological optics of the colours of double stars. This paper is sufficiently interesting, but it would have been better to describe the work of Hertzsprung, for example, or that of Tikoff; and instead of introducing the gentle gibe at the fanciful colour scheme employed in such an ancient work as Webb's "Celestial Objects," Espin's or Frank's colour scales might have received mention.

Although the title admittedly affords the author considerable liberty in choice of material, yet, since in these days the historical scale of star magnitudes has been everywhere abandoned, perhaps the sole important exception being the catalogue of Boss, there might well have been given some account of the absolute scale of magnitude adopted by the astrographic conference in 1909, especially as this crowned the thirty years' work of an American astronomer, Prof. E. C. Pickering.

So much attention is now being claimed by photo-electric photometry that many who cannot turn to the original memoirs will read the chapter on this topic with interest. As no account is given of work on, or with, selenium prior to that of Stebbins, it may be permissible to recall some facts not so widely known as they deserve to be. Announced by Mr. Willoughby Smith early in 1873, a little later Lieut. Sale, R.E., investigated quantitatively the effect of varied illumination on the conductivity of that element, the property employed in the commercial selenium bridges used in 1907 by Stebbins with such great success. Three years after Sale's experiments, Prof. Adams and Mr. R. E. Day detected the potential difference set up under similar conditions. The late Prof. G. M. Minchin applied this fact nineteen years later, in 1895, in what would appear to have been the first successful photo-electric measures of stellar radiation ever made.

It is rather to be regretted that space was not found for some discussion of the classification of variable stars instead of merely stating that the Harvard scheme is best known and most widely used. It may be, but it bears much the same relationship to present-day knowledge of stellar variability that Secchi's classification does to the Harvard classification of stellar spectra.

The later history of Novæ is even more interesting than would appear from p. 255. It has now been established that in their latest phases several, at any rate, have assumed the Wolf-Rayet features after passing through the nebular stage. It may here be mentioned that the note on p. 36 does not contain Prof. Fowler's latest conclusions regarding the Pickering and the

Rydberg series lines. In 1914 he ascribed these series to proto-helium.

An English writer would have referred to the Franklin-Adams star charts, and instead of the atlases of Heis, Schurig, or Upton, British readers will no doubt prefer, according to ambition and purses, Cottam's charts, or the atlases of Peck, Proctor, or Norton.

It is a decided merit of the book that it contains a large number of references to original publications. Moreover, it is well printed and free from typographical faults (a gross example was noticed on p. 165). It may be pointed out that the "Rutherford" several times mentioned should be "Rutherfurd," and that a revised edition of the late Miss Clerke's "System of the Stars" appeared about ten years ago. These two books, it may be stated, are in a degree complementary.

H. E. GOODSON.

OUR BOOKSHELF.

Alcohol and the Human Body. By Sir Victor Horsley and Dr. M. D. Sturge. Fifth edition. Pp. xxviii + 339. (London: Macmillan and Co., Ltd., 1915.) Price 1*s*. net.

IN this book, which has now reached a fifth edition, a striking array of statements and facts is marshalled on the deleterious effects of alcohol on the human body. The first chapter deals with the action of alcohol as a drug, the second with the chemistry of alcohol and of alcoholic beverages. The remainder of the book deals with the action and effects of alcohol—on the cell, on the various tissues and organs, on the metabolism of the body, and on the emotions. Concluding chapters discuss the relation of alcohol to disease and tropical conditions, and its use in the Services, and finally Dr. Arthur Newsholme sums up the influence of the drinking of alcoholic beverages on the national health.

The authors are well known for their pronounced views on the alcohol question, and the book must therefore be regarded as being somewhat of a partisan nature, but a good case is made out for the deleterious effects of alcohol even in small quantities, and as a general summary of the whole alcohol question there is probably no better, with the limitation expressed. The text is plentifully illustrated with a number of plates and drawings of the effects of alcohol on the tissues, etc., and with diagrams of statistical and other data.

Proceedings of the Yorkshire Geological Society. Vol. xviii. *Bibliography of Yorkshire Geology* (C. Fox-Strangways Memorial Volume). By T. Sheppard. Pp. xxxvi + 629. (London, Hull, and York: A. Brown and Sons, Ltd., 1915.) Price 15*s*. net.

YORKSHIRE long ago made its appeal to geologists on account of its magnificent coast-sections, carved out of strata abounding in marine remains. In memory of the work of the late Mr. C. Fox-Strangways, who was so long connected with the Geological Survey, the Yorkshire Geological Society has issued a bibliography which will be of value wherever Carboniferous, Jurassic, and Glacial deposits arouse interest. The work has been based on an incomplete manuscript prepared by Mr. Fox-Strangways, and has been undertaken in a most thorough spirit by Mr. T. Sheppard, of the Hull Museums, who is well known by his "Geological Rambles in East Yorkshire."

The material is arranged chronologically, beginning with Leland's "Itinerary" of 1534. We are glad to see Holinshed's "Chronicle" (1577) quoted as adding something to geology, though here, probably, a page-reference should have been given. The mineral waters attracted scientific attention before the fossil molluscs; but we find M. Lister in 1671 acknowledging in Yorkshire the influence of "M." Steno "concerning Petrify'd shells." An index of 126 pages renders reference easy, and even delightful, to the bibliography. The search for some particular piece of information at once reveals how much more has been published than any reader could have suspected from his own general knowledge.

G. A. J. C.

Chemical Constitution and Physiological Action. By Prof. L. Spiegel. Translated, with additions, from the German by Dr. C. Luedeking and A. C. Boylston. Pp. iv + 155. (London: Constable and Co., Ltd., 1915.) Price 5*s*. net.

THIS modern branch of treatment is based upon organic chemistry, and in the synthetic preparation of remedies a knowledge of the relationship between chemical constitution and physiological action is obviously necessary. This knowledge, however, is not so advanced that it is possible to foretell what change in a drug's action will be produced by the introduction into it, or the removal from it, of certain organic radicals (alkyls, carboxyl, etc.). Certain chemists take a different view, and hold that data have sufficiently accumulated to warrant such predictions, and the little book under review is written from that point of view.

Pharmacologists and therapeutists, however, who alone have the right to pronounce an opinion because they have practical experience of the action of drugs, are opposed to this enthusiastic opinion. They know that the so-called laws of the chemists have so many exceptions (in fact, as a rule, the exceptions are more numerous than the cases which fit into the chemists' views) that they maintain that the only proof of a drug is the administration thereof. Accurate, careful, and critical discussion of these questions will be found in any standard English text-book of pharmacology, and it is not easy to understand why anyone should have considered it worth while to present to English readers a translation of Prof. Spiegel's German ideas.

W. D. H.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Place of Science in Education.

THE memorandum regarding the neglect of science to which you refer in your leading article last week fails in my judgment by its moderation. The proposal that at least as many marks in the Civil Service examinations shall be allotted to science as to classics, may be a step in the right direction, but it is a halting one, for it affects only a limited class of the community and does not insist on the *paramount importance* of science in general education. What should be stated is not the least, but the whole of what is necessary. What ought to be made clear is that science must form not a mere adjunct but the actual foundation of the education given in secondary schools. In a word, what is wanted is a *revolution* in our educational system.

Unless the public appreciates the necessity for the change no such revolution is possible; when it does, the mechanism of converting the proposition into action will be simple. If the democracy once understands that we have no chance of keeping our place in the sun unless we are prepared to recognise that whether in peace or war science must be the dominant factor in education all difficulties will disappear. But if this idea fails to take root our place will be lost; and such a place once lost can never be regained. The revelations which have come to light in the course of this bloody war will, we hope, do at least this good, that the people may be induced to appreciate the necessity of basing education upon natural science instead of upon the classics.

The appointment of a Minister of Science which is advocated in the memorandum would under existing conditions be of little use. Whatever qualifications he might be selected for, we may safely prophesy that entire ignorance of the subject he is to administer would be one. It might, however, be argued that this would be a useful asset, for he would at least be gloriously impartial in the various branches of science which would come under his administration.

E. A. SCHÄFER.

University of Edinburgh, February 14.

Relations between the K and L Series of the High-Frequency Spectra.

KOSSEL has shown that for the K and L lines in the high-frequency spectra the following relation holds good:—

$$\nu_{L\alpha} = \nu_{K\beta} - \nu_{K\alpha} \text{ where } \nu \text{ is the frequency.}$$

This relation is deduced on the assumption of the Bohr-Rutherford's atomic model. As the result of new measurements, J. Malmer in his inaugural dissertation, Lund, 1915, states that the K series consists of four lines, called α_1, α_2, β_1, β_2, and that Kossel's relation must take the form—

$$\nu_{L\alpha} = \nu_{K\beta_1} - \nu_{K\alpha_2}.$$

An investigation of the spectra of the L series, which has been carried out by E. Friman and the writer, has shown that there is in reality an additional line near the $L\alpha$, with a slightly greater wave-length. Further, the L series contains two lines, called by Moseley the β and γ lines, which I will denote by β_1 and β_2, as they seem to be a doublet. The ϕ lines observed by Moseley are probably due to some impurities, as they fit fairly well in a series if they are ascribed to other elements. For antimony, we have, according to Malmer, the following relative results:—

		λ		ν
$K\alpha_2$	...	0·472	...	2·119
$K\alpha_1$	...	0·468	...	2·137
$K\beta_1$	...	0·416	...	2·407
$K\beta_2$	...	0·408	...	2·451

From this we get:—

	ν	λ calculated	λ for L series measured
$K\beta_1 - K\alpha_2$	0·285	3·51	$3·46 = \alpha_1$
$K\beta_1 - K\alpha_1$	0·267	3·74	[3·7] .. α_2
$K\beta_2 - K\alpha_2$	0·332	3·01	[3·06] . β_2
$K\beta_2 - K\alpha_1$	0·314	3·18	3·25 β_1

The values in the last column are those given by Moseley for $L\alpha_1$ and $L\beta_1$, and the values for $L\alpha_2$ and $L\beta_2$ are extrapolated.

MANNE SIEGBAHN.

Physical Laboratories, Lund, Sweden,
January 1.

Educational Work in Museums.

IN view of the decision of the Government to close the national museums and art galleries and its probable influence on those responsible for provincial institutions of the same kind, it would perhaps be useful to direct attention to its effect on a branch of museum work which has been started in Manchester as a direct result of the effects of the war.

Owing to the taking over of their buildings for military hospitals, several schools in the Manchester district found themselves temporarily without homes. In order to meet this emergency, the education authorities have instituted what might be termed a half-time system in certain of the remaining schools in order that the scholars from the dispossessed schools should have at least some instruction. The problem then arose of what to do with the scholars for the other half of their time. The Museum Committee was consulted, and asked what help it could render in the emergency, and the keeper of the museum, in consultation with the education authorities, drew up a scheme under which the scholars are now receiving instruction in natural history and Egyptology in the museum buildings.

The education authorities appointed two teachers, already on their staff, to take charge of the work at the museum, one to teach biology and the other geology. The committee placed two rooms at the disposal of the teachers and provided them with duplicate specimens from the reserve collections which could be used and handled freely by both teachers and scholars.

Courses of lessons in geology and natural history were drawn up by the teachers in consultation with the staff of the museum, framed according to the time available and the number of scholars to be dealt with.

Eight classes—of one hour's duration—are held daily, four by each teacher: two in the morning and two in the afternoon. Each lesson consists of from thirty to forty minutes' instruction in the classroom, followed by a tour of the cases in the museum dealing with the particular subject taught, and each course consists of about nine lessons.

In addition to the instruction in natural history the assistant in charge of the Egyptian department gives short courses of lessons in Egyptology to school classes, and four such classes are held weekly.

By these arrangements effective instruction in the museum is provided for 900 to 1000 children per week.

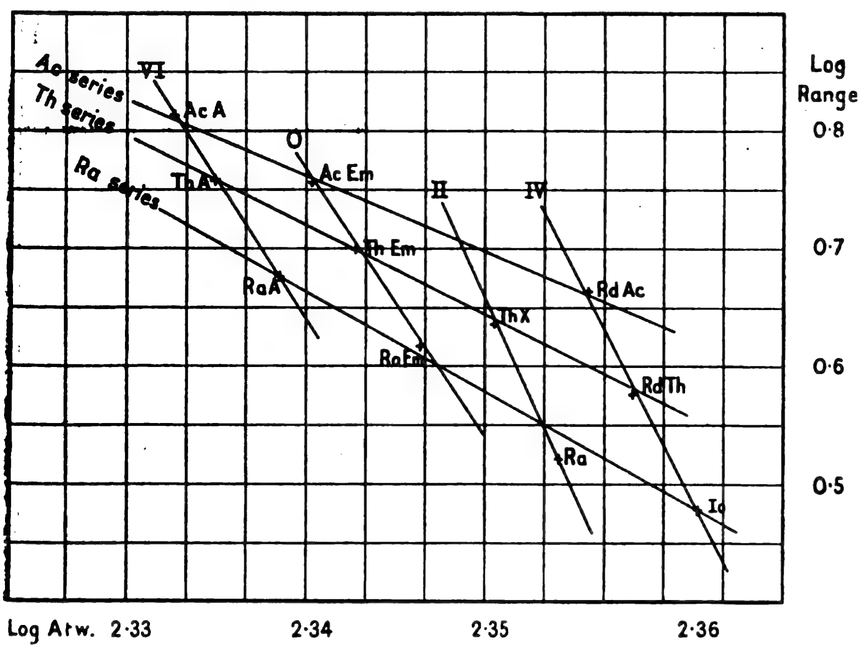
This work was undertaken in response to the appeal of the Education Committee, and in one sense at least it may be regarded as war emergency work. Its real value and usefulness have already been appreciated by the education authorities and by the teachers. But if the museum should be closed down, how can the work go on? What is to be done with the children? They have already been deprived of their schools by the military authorities. It is very desirable that they should not now be denied the valuable alternative instruction provided for them. The same problem will probably arise in many of the provincial towns in the country where similar work is being done.

W. M. TATTERSALL.

The Manchester Museum.

A Relation between Atomic Weights and Radio-active Constants.

THE interesting relation given by Mr. F. Gilbert Carruthers in NATURE of January 20, p. 565, holds, for



corresponding isotopes, nearly exactly, if, as suggested by Fajans, the atomic weight of actinium should be 227 instead of 226. From IV. to VI.B the only exception is AcX (and perhaps Ra). But the lines are not parallel, and not equally spaced.

A. VAN DEN BROEK.

Gorsel, Holland, January 25.

Asteroids Feeding upon Living Sea-Anemones.

As bearing upon the observations recorded by Mr. H. N. Milligan in NATURE of February 3, I should like to say that two of ten specimens of *Eupargurus prideauxii*, which have been kept in the aquarium of this institution since last autumn, died on January 23. The molluscan shell occupied by one of these specimens was that of *Trochus magus*, that occupied by the other was of *Scaphander lignarius*. Both shells were, as usual, enveloped by a specimen of the anemone *Adamsia palliata*. When I first noticed the dead hermit-crabs both lay on the gravel at the bottom of the tank with their ventral surfaces uppermost, and in both cases the abdomen was partially withdrawn from the molluscan shell. Both had been attacked and partially enveloped, one by two half-grown specimens of the asteroid *Porania pulvillus*, and the other by one rather larger specimen.

As I have for some time been interested in the feeding habits of Porania and Solaster, I wished to see what would happen and did not disturb the specimens until the following morning. I then found that no appreciable impression had been made by the starfishes upon the soft abdomens of the hermit-crabs; but I was much interested to find that in both cases the enveloping anemone had discharged a considerable number of acontia, with which the actinal surfaces of the starfishes, and probably their partially everted stomachs, had been in contact.

My observations of the feeding habits of Porania have extended over two years, and I have invariably found it an exceedingly slow feeder. As shown by Gemmill (Proc. Zool. Soc., March, 1915, p. 13), this species is capable of subsisting for long periods upon microscopic food particles swept into the digestive tract by ciliary currents. My own observations tend to confirm those of Gemmill; and in view of such a capacity it appears to me to be remarkable that a voluntary attack should have been made upon so large a morsel as the abdomen of a Eupagurus, especially when protected, as is commonly assumed, by an actinian. The anemones did not show any outward sign of injury beyond partial relaxation of their hold upon the molluscan shells.

H. C. CHADWICK.

The Biological Station, Port Erin.

Colourless Crystals of Hæmoglobin.

CRYSTALS of hæmatoidin in old blood extravasations in tissues are not—or at any rate have not been in the cases I have examined—soluble in chloroform or other solvents of bilirubin either with or without acidification. The colour dissolves out readily enough, but a transparent shape remains in the form of the original crystal. I have assumed that this remnant is a proteid basis similar to those which are well known in the crystals of urinary deposits and in calculi, and it is possible that Prof. Fraser Harris's curious experiences with hæmoglobin crystals are explicable along these lines. It is at least likely that hæmoglobin crystals prepared in the ordinary way contain also some serum proteid.

A. E. BOYCOTT.

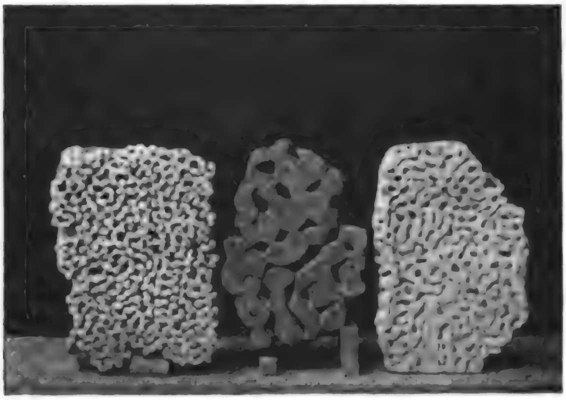
17 Loom Lane, Radlett, February 4.

Tubular Rock Structures.

THE council of the Geophysics Society desires to obtain records of mineral growths taking the form of hollow cylinders—those not due to organisms, and

consisting of either lime, silica, iron, or other elements. Any such information from your readers would be valued.

The Magnesian Limestone of Sunderland has perhaps the largest number of these calcareous growths, of which this illustration shows three specimens. The first and third show clearly the change from rods to



Tubular structures in magnesium limestone. × ½.

tubes, the last being the most advanced and typical as to size. That in the centre is extra large, but the process is incomplete.

Other illustrations of the structures in the Fulwell Hill beds can be seen in NATURE of January 29 and December 31, 1914. GEORGE ABBOTT.

2 Rusthall Park, Tunbridge Wells, February 3.

WILD AMAZONIA.

THE author, whilst fretting on the Active List owing to ill-health contracted in the interior of East Africa, happened to read Wallace's classical "Travels on the Amazon," with the result that he left England in the month of April, 1908, reaching Manaos by the end of May. His serious work began in the middle of August at Encanto, the place of "enchantment," now by irony of fate of Putumayo fame. Thence he disappeared for some months in the wilderness, roaming over some 40,000 square miles of that no man's land claimed by Brazil, Ecuador, and Peru. His company was composed as follows:—Above all, John Brown, a Barbados negro, as personal servant, who proved himself a very good choice; eight Indian carriers who were changed often, mostly because they ran away; two half-castes, rubber-collectors who attached themselves to the party for some time; and eight Rationales or semi-civilised Indians, with three women, and armed with Winchesters. It is customary, in most Latin-American countries, to distinguish as "reasonables" those Indians who have been broken in to the white man's ways; other tribes are *bravos*, *reduzidos*, and *manzos*, *i.e.*, still wild, broken, or tame.

The danger of these travels arises from the wild natives, who, not understanding the object of a white man's presence, think it best to kill him, provided there is a chance of doing so without danger to themselves. An attempt to clear up the fate of the French explorer Robuchon, lost in 1906, was unsuccessful. When possible, travelling was done by launch; that down and up the Japura river by canoe; but by far the greater part of the journeys was across country, and therefore the most difficult in every respect.

FIG. 1.—Andoke bamboo case with darts for blowpipe and gourd full of cotton. From "The North-West Amazons."

The seven months' travelling make an extremely complicated course.

Experienced traveller as he was, Captain Whiffen, in order to get an insight into the Indians' mode of life, sank all notions of superiority, manners, and customs, and practically lived their kind of life. Information could be obtained only by closest observation. The language is always the difficulty, and yet slurred over

[1] "The North-West Amazons. Notes of Some Months Spent among Cannibal Tribes." By Capt. T. Whiffen. Pp. xvii+319. (London: Constable and Co., Ltd., 1915.) Price 12s. 6d. net.

by so many travellers' accounts, which give the impression as if they were the most accomplished of linguists. Our author, however, tells us upon what slender links his verbal information sometimes depended; English John, the negro, knew Witoto well, and one of the Witotos of the party knew a little Andotu, a tribe from which original information was wanted. In such a roundabout, laborious way some of the vocabularies and phrases published in the book had to be compiled.

Our traveller does not give a glowing account of the dreary monotony, discomfort, and ever-present danger in the bush, "the weary stretches of inundated country and sweating swamp, where you pass with an unexpected plunge from ankle-deep mire to unbottomed main stream. The eternal sludge without a stone or honest yard of solid ground makes one long for the lesser strain of more definite dangers or of more obtrusive horrors. The horror of Amazonian travel is the horror of the unseen. It is not the pursuit of unfriendly natives that wears one down; it is the absence of all sign of human life. Only the silent message of a poisoned arrow or a leaf-roofed pitfall tells of their existence somewhere in the tangled undergrowth." "Game being always hard to shoot in the bush, and fish, if plentiful, hard to catch, the real fear of starvation, after, perhaps, the ghastly dread of being lost, is the greatest cause of anxiety." The necessity of having to carry rifles and food (half of the tinned provisions turned out to be bad) forced him to travel without a tent!

The present book is not a story of travel, scenery, and adventure; in fact, not an account of what the author did, but a series of reports of observations concerning the natives in every respect—their physical conditions, mode of life, beliefs, folklore, languages, music, implements, customs; and most of the respective chapters are written and self-criticised from the wider point of comparison with other peoples of other lands, and thus this many-sided work will prove of great value to the student of anthropology. Only a few instances can here be mentioned. The Japura tribe carefully retain the teeth of the slain, to be made into necklaces as a visible and abiding token of accomplished revenge. This removal of the teeth may be held synonymous with the curse of many savage tribes in reference to their enemies, "Let their teeth be broken"; *cf.* also King David, and possibly the reason is a reversion in thought to the time when teeth were man's only weapon.

A large number of spider-monkeys were observed, with tails so prehensile that they served as additional hands to convey fruit to their mouths. Some tribes consider it beast-like, unclean, to eat birds' eggs, although they eat those

FIG. 2.—Okaina Dance. From "The North-West Amazons."

of turtles and the combing of their own head-fauna. There is a tribal hot-pot over the chief's fire in the big communal house to which all the unmarried men must contribute, besides the individual family hot-pots. The newborn child is washed and ducked in the river; if it is not strong enough for this drastic treatment, it had better die; large families not being wanted, there is a vigorous weeding-out, after birth, females first.

Besides a large map, and a small one for the chapter on languages and dialects of these very locally and sparsely populated wildernesses, the book is embellished with many, mostly excellent, photographs, which are a record of industry and patience where films proved useless on account of

the moist climate. The groups of natives were always taken as they lived, according to climatic and psychological essentials, the women naked and often painted, the men unembarrassed by more than a loincloth.

THE AMERICAN STATE AND HOUSEHOLD SCIENCE.

THE application of science to national life and industry in the United States proceeds apace, and affords a very interesting spectacle in its variety of methods and experiments. Undoubtedly great progress is being made amidst a great deal of talk, and America bids fair to rectify itself in relation to science much more quickly than we can do even under the stupendous impact of war and all that it threatens to us. In this process of rectification the United States Government appears to be taking a discreet and effective part. A Bureau of Standards sounds more like Berlin than Washington, but the name is misleading if it suggests bureaucracy and punctilious standardisation. The circulars of the Bureau are, in fact, very careful and admirable scientific publications conveying a vast amount of extremely useful information, usually written in a human way and having behind them nothing in the shape of an act of legislature or compulsory standardisation. The Government gives a lead, it shows you something of which you may avail yourself; you may take it or leave it, but, at any rate, it is there. It is a calamity that we cannot say as much for our own country, where a Board of Trade hardly seems to understand what you mean when you ask it to embody a scientific element.

In one of its latest circulars[1] the U.S. Bureau of Standards enters upon a new path, attempting to reach the household:—"(1) To give information as to wants, methods, and instruments of measurement useful in household activities; (2) to describe available means of assuring correct quantity in articles bought by weight and measure; and (3) to give other facts of interest which would awaken an appreciation of the *rôle* of measurement in daily life."

Stress is laid on the educational value of such measurements and on the increase of efficiency in the household, which comes from the habit of thinking in terms of units and definite quantities. The introduction is indeed a temperate and admirable appeal for increased accuracy and better knowledge in the use of household appliances and in the conduct of household operations.

The substance of the circular is comprehensive. It includes chapters on commodities, heat, light, electricity, gas, water, atmospheric humidity, atmospheric pressure, density of liquids, time. In each case the trade and household measuring instruments related to these topics are carefully described both in principle and in mechanical detail, and excellent illustrations abound. There is an abundance also of useful hints directed towards securing efficiency and economy, and, in fact, the circular might be called in many respects a treatise on that ambiguous subject known as domestic science.

As such it suffers from a common defect, namely, the attempt to expound scientific principles piecemeal and incidentally, or parenthetically, to single applications. This kind of defect is always visited with severity by the more academic critics, but it may be urged that the defect is not so great as it seems. It is true enough that the contents of this circular, so far as they call for scientific comprehension, will be unassimilable by the ordinary mistress of the household who has only received the one-sided and largely unnegotiable gift of "a good general education." But it is equally true that the anchorage of sound scientific explanations to things and processes of the most obvious practical utility is as likely as anything to direct attention to what has been neglected in one generation and may be secured to another.

Something must be done to demonstrate the place of science in practical affairs, and this seems a legitimate way. Our educational masters seem to make most of their mistakes by forgetting that they are exceptional members of society in having an enthusiasm for abstract knowledge. No doubt the love of knowledge for itself exists to some degree in everyone, and may be developed; but the ordinary circumstances of the world make most people, even at an early age, want to know what use is to be made of knowledge. The fastidious exclusion of the useful from the exposition of the good and true is an unnecessary and fatal extravagance of the pedagogue, and nowhere has its incidence been more lamentable than in the case of natural science. Are we not at the moment bemoaning a nation that does not even know that science is useful? Who or what is responsible for this? Many answers are given, but none is nearer the truth than this: that our teaching has failed. How and where it has failed might be well illustrated by this circular, if those who are engaged in teaching science to the future housewives of England could be examined upon the contents. We should see the reason why such a gap remains between the science of our schools and science in actual use. There is a missing link. It is true of the domestic world, it is true of the industrial world, it is true of the whole national life, and there is urgent need of a remedy. The publication under notice helps to fill one gap, and it should be of real value to those engaged in teaching science to future housewives; and it will help also towards making boys' science more mobile in their homes.

A. S.

[1] U.S. Department of Commerce. Circular of the Bureau of Standards No. 55. "Measurements for the Household."

THE CLOSING OF MUSEUMS.

A PROTEST against the closing of museums (including art galleries) was made to the Prime Minister on February 10 by a deputation representing the Museums Association, the National Art Collections Fund, the Royal Asiatic Society, the Hellenic Society, the Art Workers'

Guild, and the Imperial Arts League. Mr. Asquith, emphasising the need for economy in every direction, explained that the Government had not accepted the recommendation of the Retrenchment Committee in full, since, in addition to the Reading Room of the British Museum, it had decided to keep open the National Gallery and the Victoria and Albert Museum. In view of the numerous colonial visitors and wounded soldiers who resorted to the Natural History Museum, a further concession might be made. "I have," said Mr. Asquith, "come to the conclusion that the portions of the museum which most interest ordinary visitors should remain open, but I do not think that the argument applies to the geological and mineralogical sections. In addition, I hold that facilities should continue to be offered to students at the museum." It was further made plain that the closing had nothing to do with the question of safety; also that the authorities of provincial museums were at liberty to do what they thought best. The galleries and the students' rooms (except that of Manuscripts) at Bloomsbury will be closed on and after March 1. As for the Natural History Departments, it remains to be seen which will be closed by the trustees as not interesting ordinary visitors.

We regret that the Prime Minister should have laid stress only on popularity, and should have paid no attention to usefulness. It is not always the most popular exhibits that are the most useful. Galleries left alone by the "ordinary visitor," *e.g.*, that of fossil invertebrates, are much frequented on certain days by collectors and students (not the "students" whom Mr. Asquith had in his mind). But, if popularity is to be the test, surely the Egyptian Department at Bloomsbury and the Fossil Mammal Gallery at South Kensington should not be closed. "Such limitations," said Mr. Asquith, "will last only for a time"; but on what the length of that time is to depend no indication has been given. Our leaders in all branches of intellectual study must be prepared for a struggle lest this action should prove a serious and permanent set-back to research and education, especially in the realms of science.

The following report of the speech made by Sir Ray Lankester as one of the deputation received by the Prime Minister will be of value to those who may be called upon hereafter to discuss this matter.

I am sure that we all agree as to the necessity for retrenchment in public expenditure and sympathise most heartily with the general purpose of the Government in this matter. But we think that the exclusion of the public from the national museums and picture galleries is not well advised, because it will result in a very small saving and a very great public loss. The widespread feeling against this closure has been made evident in the daily Press and by the support given to the present deputation. But I should not wish to urge this as decisive. We fully recognise that the Prime Minister may consider it to be necessary, however reluctantly, to effect this economy; our object is to state facts which seem to us to show that the advantages of such a course are altogether outweighed by the disadvantages. We think that the Committee on Retrenchment which has reported to the Government in favour of the closure of all public museums and galleries, excepting the reading-room of the British Museum, has not had the facts fully in view.

The great national museums and picture galleries are not mere shows. They, like the great cathedrals which stand always open, are places of rest and mental refreshment in this time of stress and anxiety. They are also a continual source of education and instruction which should not be abandoned even during war, except in case of dire necessity. Were they closed those who now frequent them would seek distraction in less worthy resorts.

It seems to many of us that, in regard to the question of closure of the museums, it is undesirable to make a rule of "all or none." Each case should be judged on its own merits. The saving of expense would be greater in one case than another, and the public disadvantage greater in one case than another. The Government, we are told, has recognised this, and has decided not to close either the National Gallery or the Victoria and Albert Museum.

I shall therefore confine my remarks to the case of the Natural History Museum, concerning which I have special knowledge, having been for some years its director. The Government does not propose to arrest the work which is done by the curators and other members of the staff in this and other museums. There is no suggestion that the collections should be allowed to deteriorate for want of proper supervision, cleaning, and protection from cold and damp. It is merely proposed to stop the free daily access of the public to the exhibition galleries of the museum. This would tend to a saving at the Natural History Museum of about 2000*l*. a year, and no more. It would be made by the reduction in the number of police and guardians employed in the public galleries. On the other hand, the building, the glass cases, and the specimens, together with the cost in the past thirty years of arrangement, preparation, and labelling of the exhibited specimens, represent a capital expenditure of not less than a million and a half pounds sterling, which, at 5 per cent., corresponds roughly to an annual sum of 75,000*l*. To this we must add the expenditure of an annual grant, voted by the House of Commons, of 45,000*l*. (reduced from 60,000*l*. to that smaller sum by special economies during the war), giving as the annual cost of the Natural History Museum to the nation a sum of 120,000*l*. It is proposed to exclude the public from this great and beautiful show in order to reduce the annual expenditure on it by one-sixtieth. This is recommended by the Retrenchment Committee as "an object-lesson in national economy." It is no doubt necessary to save small sums here and there in many directions of public expenditure. But it must seem to most people absurd to spend so large a sum on a splendid institution and then, for the sake of a relatively minute reduction of that expenditure, to sacrifice one of the main purposes—if not the main purpose—for which the great expenditure is made—namely, the public edification. It is a maximum of loss and injury to the public with a minimum of financial profit to the National Exchequer.

To obtain a small saving in this way by excluding the public, for whom it exists, from one of its most costly and valued possessions would, moreover, show not only an almost ludicrous misapprehension of the relative proportions of sacrifice and gain, but would be open to the objection that such action involves a breach of trust on the part of the Trustees, and is contrary to the Act of Parliament under which they exist. The money by which the Natural History

Museum has been built, fitted, and furnished, and that by which it is maintained in full efficiency, has been annually voted by Parliament, and generous benefactors have given priceless collections to it on the express understanding that the museum is—by Act of Parliament—a permanent national possession daily open to the public. It is, of course, understood that the Trustees may close it on certain days for administrative purposes, and in case of national disaster the Government would be justified in suspending all expenditure upon it. But the endeavour to save a minute fraction of the annual cost of the museum by hastily closing its doors in its owner's face, must lead to public resentment and want of confidence in the Trustees, who alone (and not the Government) are by Act of Parliament distinctly charged with the public duty of keeping it open. As a consequence there might very probably be a resistance in Parliament to the passing of the annual grant by which the museum is maintained, and the good work done there might be curtailed or brought to an end.

It has long been the policy of those who have duly understood the position of the Natural History Museum to give every facility and every assistance to the public in the use and enjoyment of its contents. It was the main care of Sir William Flower when director to make the galleries both delightful and really educative. In that respect I, in my turn, followed him, and recognised as a fundamental principle of administration that the public must be enabled, in every possible way, to understand and to enjoy the great museum for which it pays. That is no more than a fair and honourable acknowledgment to the taxpayer of the large sums which his Parliamentary representatives (quite independently of the Government of the day) place in the hands of the staff of the museum for the purpose of scientific research and discovery and the maintenance of the museum as a centre of study and expert advice. It is only by securing for it the intelligent interest and appreciation of the public that the Natural History Museum can be assured of the continuance of its annual subsidy. That view, I may say, was one which was often expressed to me by our late King Edward, when, as Prince of Wales, he was a trustee of the museum. It seems to me that to shut the public out of its museum in order to spare expenditure on the wages of a few superannuated soldiers as watchmen, would be to give public offence without any prospect of compensating advantage, and I therefore venture to hope that the proposal to do so may be reconsidered.

An error, for which we were not responsible, crept into the figures of attendance at the Colchester Corporation Museum, to which we alluded last week. The week-day figures for the last nine months of 1915 were 39,933. But, even so, the numbers seem to have been quite double those of ordinary years.

NOTES.

We announce with deep regret the death on February 15, in his eighty-fifth year, of Sir William Turner, K.C.B., F.R.S., principal and vice-chancellor of the University of Edinburgh.

We see with much regret the announcement, in the *Times* of February 11, of the death of Prof. I. P. Pavlov, a foreign member of the Royal Society, late professor of physiology in the University of St. Petersburg, and director of the Imperial Institute for Experimental Medicine.

Sir E. Vincent Evans has been appointed chairman of the Royal Commission on Ancient Monuments in Wales and Monmouthshire, in succession to the late Sir John Rhys.

The death is announced, in his sixtieth year, of Dr. J. O. Reed, who had been connected with the University of Michigan since 1892, as successively, instructor, assistant professor, and professor of physics. He was the author of a text-book of "College Physics," and, with the late Prof. K. E. Guthe, of a "Manual of Physical Measurements."

According to the *British Medical Journal*, the foundation-stone of the Hospital for Tropical Diseases of the Calcutta School of Tropical Medicine will be laid on February 24 by Lord Carmichael, the Governor of Bengal. We learn from our contemporary that the whole of the money required for the building has now been collected.

At the meeting of the Prehistoric Society of East Anglia on February 7 Mr. J. Reid Moir read a paper on Palæolithic implements found at Darmsden, Suffolk, in a high-level plateau deposit. Some are choppers or scrapers, while others appear to have been used as borers. All have been made from Lower Eocene pebbles, and appear to represent a hitherto unrecognised type.

Among the goods of which the import is prohibited by a Proclamation to come into force on March 1, are:—All materials for the manufacture of paper, including wood pulp, esparto grass, and linen and cotton rags; paper and cardboard (including strawboard, pasteboard, millboard, and wood pulp board), and manufactures of paper and cardboard; and all periodical publications exceeding 16 pages in length, imported otherwise than in single copies through the post.

The committee of the Privy Council for Scientific and Industrial Research has appointed the Hon. Sir C. A. Parsons, K.C.B., F.R.S., to be a member of the Advisory Council in place of Prof. B. Hopkinson, F.R.S., who has been forced to resign by the pressure of his military duties and special work connected with the war. The committee has also appointed Prof. J. F. Thorpe, F.R.S., to fill the vacancy on the Advisory Council caused by the death of Prof. Raphael Meldola, F.R.S.

According to the Cape Town correspondent of the *Times* (February 11), the Rand has been subject to a series of earth-tremors, which have lately been increasing in frequency and strength. A committee appointed to investigate them has issued a reassuring report. The shocks, it appears, are purely local, being the result of mining operations, and therefore unlikely ever to be of a destructive character. They seem to resemble the earth-shakes which are not uncommon in the mining districts of this country, and are probably due to small movements along faults precipitated by the withdrawal of coal or water.

The *Nieuwe Courant* of February 3 announces the death, from heart failure, of Dr. August Michaelis, professor of chemistry in the University of Rostock.

Dr. Michaelis published numerous papers on organic derivatives of phosphorus, arsenic, antimony, and of other elements. His first paper in the *Berichte*, on phosphorus sulphobromide, dates back to 1871, and almost his last was a long paper on organic compounds of phosphorus and nitrogen, in the *Annalen* of last year. He was successively connected with the technical high schools of Karlsruhe and of Aix-la-Chapelle, and had been for the last twenty-five years at Rostock.

THREE volumes of special reports on the mineral resources of Great Britain, prepared by the director of the Geological Survey in response to numerous inquiries that have arisen through the conditions brought about by the war, have just been published. In vol. i. the uses, distribution, treatment, and output of tungsten and manganese ores are dealt with, and particulars of the mines, active and inactive, are given. The second volume deals with the sources, uses, and treatment of barytes and witherite (the sulphate and carbonate of barium). The mines from which the minerals are or have been raised are described in detail. Vol. iii. of the series deals with the properties, uses, treatment, and modes of occurrence of gypsum, anhydrite, celestine, and strontianite. Details of the workings in all parts of Great Britain are given, with statistics as to output. Copies may be obtained through any bookseller, or from the Director-General, Ordnance Survey Office, Southampton.

ONE of the most talented and promising of our young botanists was lost to science on January 5, when Capt. A. S. Marsh, of the 8th (Service) Battalion, Somerset Light Infantry, was shot through the heart by a German sniper on the western front. We are indebted to Mr. A. G. Tansley for the following particulars of Capt. Marsh's career and work:—Marsh was born at Crewkerne in 1892, and was educated at Sexey's School at Bruton. He began residence at Trinity College, Cambridge, in 1909, took the first part of the Natural Sciences Tripos in 1911, and the second part in 1913, and was placed in the first class in both parts. In 1913, also, as a result of getting a Frank Smart studentship in botany, he migrated to Caius. Marsh demonstrated in the elementary botany and elementary biology classes at Cambridge and also in Dr. Moss's field classes. The vigour with which he devoted himself to military work, his evident success with his men, and his popularity among fellow-officers perhaps surprised some of his friends, for Marsh had seemed essentially a student. He published four botanical papers:—"Notes on the Anatomy of *Stangeria paradoxa*" (*New Phytologist*, January, 1914); "The History of the Occurrence of Azolla in the British Isles and in Europe generally" (Proc. Camb. Phil. Soc., February, 1914); "The Anatomy of some xerophilous species of Cheilanthes and Pellæa" (*Annals of Botany*, October, 1914); and "The Maritime Ecology of Holme-next-the-Sea, Norfolk" (*Journal of Ecology*, June, 1915). All his papers showed marked ability, and the most important—a study of the salt marsh near Hunstanton—is a piece of work admirably conceived and executed. Before he left Cambridge, also, he devised some ingenious experiments in competition between closely allied species of plants which in nature occupy different habitats, and these were beginning to give valuable information on the ecological relations of the species. But at the time he joined the Army, Marsh was only just beginning to "find himself" intellectually, and it is impossible to say what he would have done in science if he had lived to return to botanical work. He was very greatly loved by those who knew him best, and his death is a bitter loss to his friends.

IN *Man* for January Prof. Ashby describes the excavation of a portion of a megalithic building in Malta, known as Id-debdieba, "The Place of the Echo." Among the objects discovered were six pillars of hard coralline limestone, cylindrical in shape, but some tapering at one end, of a type common in Maltese megalithic buildings; a few flint implements; a quantity of Neolithic pottery, with other fragments showing that the site was occupied in Greek and Roman times.

IN the American *Museum Journal* for December last Mr. H. Lang describes, with a fine set of photographs, his work of exploration in the Congo valley. He points out that the result of the present war will be even more disastrous to these native races than to the peoples of Europe. The direct loss of life will be largely confined to the white officers; but the dispersal of hosts of armed native warriors when the hostilities are over will inevitably lead to a wide extension of the dreaded plague of sleeping sickness. The usual prophylactic measures have been seriously weakened as a result of the war, and there is little hope of checking the plague in the absence of a well-equipped medical service entailing enormous expenditure, for which the necessary funds cannot be provided.

THE always interesting problems on motion raised by Zeno, and continued at recurrent intervals ever since, form the text of an amusing article, "The Flying Arrow," by P. E. B. Jourdain, in *Mind* (New Series, No. 97). The shade of Zeno is represented as being conversant with all the mathematical and philosophical works, including the periodic literature, since his day, and with Socrates as his victim and auditor he analyses critically those who have wrestled with his paradox of the flying arrow. The writer's view is that all four arguments are directed against the belief that lines are made up of points. Both philosophers and mathematicians will find the article stimulating and subtly amusing.

THE twenty-ninth annual report of the Liverpool Marine Biology Committee, in addition to the usual accounts of work at the Port Erin Station, contains an address by Prof. W. A. Herdman on the life and work of Edward Forbes. Reading this vivid account of an arduous and fruitful career, the naturalist of to-day cannot but mourn the loss which biological science suffered from Forbes's early death in 1854, a few months after he had attained "the goal of his ambition, the chair of natural history at Edinburgh." Prof. Herdman's appreciation of Forbes's work is wise and generous, yet present-day students of distribution

will consider that less than justice has been done to Forbes's classical Survey Memoir on the fauna and flora of the British Isles. So far from "the three southern subfloras of Forbes in place of being the oldest, as he supposed," being now known to be the most recent, the relatively high antiquity at least of Forbes's Lusitanian flora has been confirmed by much recent work on the natural history of Ireland and western Britain.

SOME interesting observations on the physiology of frogs are recorded by Messrs. A. T. Cameron and T. I. Brownlee in the *Quart. Journ. Exp. Physiol.*, vol. ix., No. 3. It is well known that frogs will endure prolonged submersion in water, efficient respiratory exchange going on through the skin. The authors find that with *Rana pipiens* in Manitoba, the average time for which the animal will live under water is sixteen days, with an observed maximum of fifty-two days. Death from too prolonged immersion is preceded by swelling, due partly to absorbed water, but largely to accumulation of absorbed nitrogen. In another paper these authors discuss the upper limit of temperature compatible with life in the frog. They had previously fixed the lower limit at approximately 1·25° C. below freezing point. They now find that *R. pipiens* cannot live for more than a few days submerged in water at 18° C., and that a few minutes' endurance of a temperature of 35° proved fatal. In damp air similar results were obtained, but the high-limit temperature requires longer to cause death. The internal temperature of the animals scarcely differs from that of the medium, and can evidently vary only within the limits mentioned if life is to be maintained.

To determine whether selection, or mutation, is the more important agency in evolution, Prof. W. Castle some time ago started a series of experiments with hooded-rats, since these afforded him the single genetic factor necessary for his investigation. A very careful analysis of the data accorded him after breeding 33,249 rats, excluding those which formed the subject of "control" experiments, seems to demonstrate clearly enough that "there is apparently no limit to the quantitative change which can be produced in the hooded pattern by selection, short of its complete extinction in the all-white, or all-black condition." This being so, then "two foundation postulates of the mutation theory are false, viz.: (1) that continuous, or graded variations, are not concerned in evolution, and (2) that selection of such variations, no matter how long continued, can effect no permanent or progressive racial changes. Selection, as an agency in evolution, must then be restored to the important place it held in Darwin's estimation, an agency capable of producing continuous and progressive racial changes." Prof. Castle states his case with remarkable lucidity in the *Scientific Monthly* for January, numerous diagrams contributing not a little to the value of this most important summary.

IN *Knowledge* for January Mr. Aubrey Drew discusses some cytological problems raised by recent cancer research. He first describes the "jelly method" of *in vitro* staining of cells, devised by H. C. Ross. An agar jelly is made, and to this sodium chloride, sodium citrate, and citric acid are added in certain proportions, and afterwards sodium bicarbonate and Unna's polychrome methylene-blue in quantities varying with the cells to be examined. For use the mixture is melted, and a drop or two placed on a slide and allowed to set. A little of the material to be examined is then placed on the jelly, covered with a cover-glass, incubated if necessary, and examined microscopically. In this way cells, such as leucocytes, can be seen dividing, and the changes in structure observed. Certain substances are found to be necessary for cell-division to take place, and are termed "auxetics," others increase cellular movements, "kinetics," and some of the latter increase the activity of auxetics and are termed "augmentors." These substances may play a part in cancer production. Thus certain auxetics and kinetics will produce tumours on injection into animals. Workers in pitch and tar are liable to be affected with cancer, but it is only gasworks pitch and not blast-furnace pitch which predisposes to cancer. By the jelly method it has been shown that gasworks pitch and tar contain both auxetics and kinetics (augmentors), but the blast-furnace products contain only traces of auxetics and no kinetics.

WE have received a copy of the list of seeds of hardy herbaceous plants and of trees and shrubs which for the most part have ripened at Kew during the past year. This annual publication, forming the first appendix of the Kew Bulletin for 1916, is a welcome sign that despite great difficulties owing to the depletion of the garden stuff, the true functions of a botanic garden are being successfully carried on at Kew.

THE Journal of the Royal Horticultural Society for December, 1915, contains an interesting and very well-illustrated paper by Mr. G. Forrest on the flora of north-western Yunnan. The plates are from Mr. Forrest's own photographs, and include remarkably beautiful studies of several of the peculiar species of Primula found in this region. The Rhododendrons are also represented by numerous species, several being dwarf alpines, which form regular "heaths." Of these *R. prostratum* grows up to an altitude of 16,000 ft. Many of the Rhododendrons were found on pure limestone rocks, but whether they are really growing with their roots in the limestone rocks or in pockets of humus was not definitely determined.

COCONUT cultivation, though still a small industry in Queensland, is rapidly extending. Hitherto it had been supposed that copra from Queensland coconuts did not contain enough oil to be of commercial value, but the examination of a sample of copra from these nuts at the Imperial Institute has now established that the oil content is normal and the copra of good quality, and brokers state that shipments would be readily saleable in this country at good prices. Before the war the bulk of the copra shipped to Europe from Ceylon, India, and elsewhere was crushed in Germany and France. Urgent representations on this subject were made by the Imperial Institute on the outbreak of war to the oil-seed crushing firms in the United Kingdom, some of which have now begun to work copra, with the result that there is a new and good

market for the product in this country, which is likely to expand when the new factories now building start work.

STUDENTS of petrography will note the description of three Indian meteorites by J. Coggin Brown ("Records Geol. Surv. India," vol. xlv., 1915, p. 209), the falls of which were actually observed between 1902 and 1914. All are referable to the prevalent sporadosiderite type, and show marked chondritic structure.

A SECOND edition of "The Geology of the Country between Whitby and Scarborough" has been issued by the Geological Survey of Great Britain (1915, price 2s. 6d.). It is practically a new work, and the description of the strata by the late C. Fox-Strangways and G. Barrow has been supplemented by a chapter by S. S. Buckman on their palæontological classification. The critical revision of the species and genera of ammonites will be very welcome to those who first examined the Whitby coast when far less exactitude prevailed. Considering how many visitors to this part of Yorkshire become here attracted for the first time to geology, we might suggest the insertion in a third edition of plates showing some of the most common forms, and the suture-lines that can be traced on rubbing down the surface of good specimens. Popular works on the Whitby district are obtainable, such as that by L. Walmsley (NATURE, vol. xciii., p. 382); but the Geological Survey is not sufficiently recognised as a powerful help in public education. The present memoir is further strengthened by a review of the glacial geology by G. W. Lamplugh.

NEARLY two years have elapsed since the circumstances of the loss of the *Karluk*, the ship of Stefansson's Arctic Expedition, were announced, but a full account of her voyage and her drift in the pack, and the escape of her crew after the sinking of the vessel, have so far been lacking. Captain R. A. Bartlett's diary from his departure from Nome to his return to Esquimalt is now published in full in the report of the Department of the Naval Service for the year ending March 31, 1915 (Ottawa). It is accompanied by a sketch map showing the drift of the *Karluk* from near Flaxman Island, where she was caught on August 12, to her destruction on January 11, north of Herald Island. The diary is characteristically brief, but it shows with what ability Captain Bartlett was prepared to handle the situation. Had all the members of the expedition taken his advice, there would probably have been no loss of life. Captain Bartlett wisely decided to bivouac on the ice for several weeks in order to harden the men and to get a track made over the rough ice by the time the light conditions improved. A road was prepared and depôts of provisions laid down, with the result that Captain Bartlett's party reached Wrangell Island in safety. How Captain Bartlett crossed to the mainland and ultimately returned from Nome with help has been told before. Unfortunately, there is now no hope of the safety of Dr. Forbes Mackay, Mr. James Murray, M. Henri Beuchat, and those members of the crew who accompanied them in their independent attempt to reach the land at an earlier date.

THE council of the Röntgen Society has drawn up and issued with the January number of the journal of the society a number of recommendations for the protection of X-ray operators. They are printed on a card, which should be suspended in a prominent position in every X-ray laboratory. In the early days of the therapeutic use of the rays many cases of X-ray dermatitis occurred, but these injurious effects may now be readily avoided. The X-ray bulb should be enclosed in a box lined with sheet lead two millimetres thick, and provided with an opening through which alone the rays required can emerge. The observer should protect himself with sheet lead of the same thickness, or with gloves or lead glass screens with an equivalent amount of lead in them. The efficiency of each screen should be tested before it is brought into use.

THE director of the Bureau of Standards at Washington gives a short account of the recent work done by the bureau in the January number of the Journal of the Franklin Institute. We have already given in these columns the results of the inquiry into the cause of the failure of fusible tin boiler plugs, and the investigation of the permissible variations in the method of manufacturing bronzes. Amongst the other subjects under investigation at the present time are:—The best platinum alloy for platinum ware, the causes of failure of wheels, rails, and other railway materials, the standardisation of test steel ingots, the distribution of the carbon in steels, the preparation of pure iron, the manufacture and properties of non-ferrous metals and alloys, and the causes of failure of structural brasses. It is impossible to read a list of investigations like this without feeling that the United States Government is providing a sound scientific basis for her industries, and that the money required for maintaining the bureau is well spent, or, we should prefer to say, well invested.

"SELLING Machinery by Motion Pictures" is the title of an article in the *Engineering Magazine* for January. Machines are generally too large to be sent for inspection by the prospective customer, and experience shows that it is very difficult to persuade him to visit the works where the machines are made. Many firms are now making a speciality of portable kinematographs, light in weight, small in size, and easy to operate. These can be connected to the lighting circuit in the customer's office with a blank wall as the screen, and the films show the mode of operation and construction of the machine in an ideal manner from the business point of view. The motion picture obliterates the seasons, and the action of a harvester can be shown in winter as easily as that of a planter in autumn. The article gives many instances of the use of the kinematograph for business purposes, and includes copies from parts of several typical films.

THE use of dry blast in the manufacture of iron and steel is discussed in *Engineering* for February 11. At least five plants have been installed in Great Britain; most of these have not been considered to yield a sufficient return for the outlay involved. Two plants erected in Germany were shut down after twelve

months' running. On the other hand, the installation at the works of Messrs. Guest, Keen, and Nettlefolds, Cardiff, shows a saving in fuel of 13·4 to 18·4 per cent. Most of the American plants have effected notable economies, varying from 10 per cent. saving in fuel and 12 per cent. increase in output, up to 20 per cent. saving and 20 per cent. increase. The explanation of these divergent results is to be found either in the variation in local conditions, or in differences of practice. In practice refrigeration is the system almost universally used. The desiccation of the blast by calcium chloride, which is the only alternative, is less costly as regards initial outlay, but it is probable that the running costs would be much higher. Typical refrigerating plants are described in the article.

OUR ASTRONOMICAL COLUMN.

COMET 1915e (TAYLOR).—The following preliminary elliptic orbit has been calculated by F. J. Neubauer and H. M. Jeffers, of the Berkeley Astronomical Department (Lick Observatory Bulletin No. 276):—Perihelion, 1916, January 27·906 G.M.T., $\omega=342^\circ$ $54'$, $\Omega=114^\circ$ $52'$, $i=14^\circ$ $30'$, log $a=0{\cdot}48282$, period 5·299 years.

The Copenhagen ephemeris for this comet proves to represent its positions very accurately. The large corrections given in this column on January 27 were in error; actually the differences were insignificant. An observation made at Bergedorf on February 1, and forwarded by Prof. E. Strömgren, shows that the corrections then required were only -3s. in R.A. and $0'$ in declination.

SECONDARY NUCLEI OF COMET 1915a (MELLISH).—A series of photographs taken with the Franklin-Adams star camera at Johannesburg are reproduced in Circular No. 31 of the Union Observatory. The subsidiary nuclei were found to lie on a line almost tangential to the coma and not axially. On June 10 the brightest secondary was 82″ distant, and another about 154″. The line joining these nuclei was in position angle, 228·8°. Other measures of the nuclei are given by Mr. Melotte in the *Observatory* for January.

ON THE MEAN DISTANCES AND LUMINOSITIES OF STARS OF DIFFERENT SPECTRAL TYPES.—Prof. C. V. L. Charlier has investigated statistically (*Meddelande*, Lunds Astronomical Observatory) the mean parallax of stars according to spectral type in relation to mean distances and luminosities for all stars down to mag. 6·0. It is found that the β stars deviate only slightly from the mean absolute magnitudes of these stars, whereas the K—and still more the M—stars are characterised by great fluctuations about their mean absolute magnitudes.

ANOMALOUS DISPERSION IN THE SUN.—The suggestion advanced by Julius that anomalous dispersion could be the cause of small alteration in wave-length of neighbouring Fraunhoferic lines was followed by a notable research leading to confirmatory results (NATURE, September 2, 1915). This work is now sharply criticised by Mr. Evershed in a letter to the January number of the *Observatory*, and by Dr. Royds (Kodaikanal Observatory Bulletin, No. xlviii.) Small wave-length shifts between sun and laboratory sources have been the subject of much minute investigation at Kodaikanal during the past few years by direct measurement on large-scale spectrograms, and data derived from these studies now enable Dr. Royds to state that when the actual sun-minus-arc displacements are substituted for Albrecht's residuals the relative shift between the two groups of solar lines having a close companion on one side or the other is too small to establish anomalous dispersion in the sun. Evershed considers the case of close solar doubles. The effect of anomalous dispersion should be to increase the separation to a measurable degree as compared with the arc, but this is not found to be the case. Nevertheless it is recognised that it is difficult to explain away the grouping according to sign of the residuals in Albrecht's investigation.

BRITISH PRODUCTION OF SYNTHETIC DYES.

IN the *Times* of February 11 a Leeds correspondent comments on current developments of the problem of increasing the production of synthetic dyes. Whatever criticisms may be advanced against the Government scheme, it cannot be denied that the appointment of Prof. W. H. Perkin, the eldest son of the discoverer of mauve or aniline purple, to be head of the research department of British Dyes, Limited, is a most welcome augury of future progress. It is, however, a debatable point whether this department, endowed by the State to the extent of 100,000*l.*, ought in the public interest to be the monopoly of a single company, which under a new name and with the aid of a large Government subsidy is carrying on the business of one only of several competing firms.

The burning question of a year ago as to the desirability or otherwise of having chemists on the directorate of a colour works has now received a striking practical illustration in the less advertised developments recently effected in the firm of Messrs. Levinstein, Limited, of Blackley, near Manchester. In accordance with the best traditions of the Manchester school of economics, this firm of colour-makers, which practises the doctrine of self-help, has made very considerable extensions of its old-established works under the skilled guidance of their director, Dr. H. Levinstein, a college-trained chemist, a double graduate in science of the Universities of Manchester and Zürich, and a former pupil of Profs. Bamberger and W. H. Perkin. Without extraneous help, the Manchester firm has now to compete for home and foreign trade and for scientific assistance against a commercial rival enjoying preferential treatment from the State. It is obvious that the latter firm anticipates a further extension of favours from the Government, otherwise it would not be practicable to develop so large an area as a 250-acre site with the existing capital and with the comparatively small sum paid up by shareholders who are dye-users. A continuance of this policy of subsidies to one firm will handicap still further the meritorious efforts now being made by other less favoured undertakings.

The research work on dye production carried out in the dyeing department of the University of Leeds, under the auspices of the Board of Trade, by Profs. Green and A. G. Perkin and Dr. Oesch, formerly of the Berlin Aniline Company, is of the utmost importance in regard to the progress of the dye industry in this country. But if the effort to recover our lost supremacy in dyes is to be truly national the benefits of this university research should, at least to some extent, be at the disposal of other dye-producing works besides the exceptionally favoured successors of the old Huddersfield firm.

THE DAILY FOOD RATION OF GREAT BRITAIN.[1]

SEVERAL estimates of the food supply of Great Britain, in whole or in part, have been published in recent years. But in none of these has a computation been made of the "foodstuffs" contained in the food, or of the energy which it furnishes to the human body. Yet these are the only standards which apply to all foods, whether solid or liquid, and taken together constitute the only applicable test by which the supply can be properly gauged. Thus we can only say whether the supply is sufficient, excessive, or deficient, when we know the quantities of protein, carbohydrate, and fat, and the amount of energy it provides per day to the consumer. Further, it is only when we have this knowledge that we can intelligently proceed to substitute articles of diet for others which may have been cut off or rendered scarce from any cause.

Such a survey of the food supply of Ireland has recently been made by the writer, and it seemed desirable that a corresponding inventory should be taken of that of Great Britain.

To do this, an independent estimate had in the first instance to be made of the total food of the country, both imported and home produced. This could only be done, with any degree of accuracy, for one particular year, that of the "Census of Production." So far the results of only one such census have been published, namely, for the year 1908. Accordingly the survey applies to this particular year; but there is every reason to suppose that it would apply equally well to any year of the last decade. The returns from which the quantities of the different food materials have been made are:—(1) Those of the Board of Trade, which give the imports and exports; (2) those of the Board of Agriculture, which give the home supplies; (3) those of the Departments of Fisheries of England, Scotland, and Ireland, which give the fish landed; and (4) lastly, those given in the Final Report of the First Census of Production, which supplement the others in necessary ways.

The Food Supplies.

These were collected under the following heads, namely:—(1) Cereal foods; (2) vegetables; (3) meat; (4) fish; (5) dairy products, eggs, margarine; (6) fruit; (7) other foods. It is only possible to give here short summaries of the estimates.

(1) *Cereal Foods.*—These include wheat flour and meal, oatmeal, rice, barley flour, maize meal, and "other farinaceous foods." The total supply is made up as follows:—

Net imports		Home produce		Total
67,506,951 cwts.	...	23,395,795 cwts.	...	90 902,746 cwts.

That is to say, 74 per cent. of our cereal food supply is imported and 26 per cent. home grown.

(2) *Vegetables.*—In this category are included potatoes, onions, tomatoes, cabbage and other green vegetables, carrots, beet, turnips, parsnips, celery, rhubarb, peas, and beans. The supplies are as follows:—

Net imports		Home produce		Total
16,360,000 cwts.	...	94,423,640 cwts.	...	110,783,640 cwts.

That is to say, 15 per cent. of our vegetables are imported and 85 per cent. home grown.

(3) *Meat.*—The supplies comprise beef and veal, mutton and lamb, pork, bacon, and hams, poultry, game, and rabbits, sausages and "offal." It is needless to say that all imported meat, including frozen, refrigerated, salted, and tinned has been included. The following are the quantities:—

Net imports		Home produce		Total
25,886,471 cwts.	...	24,577,994 cwts.	...	50,464,465 cwts.

Thus in round numbers 51·5 per cent. of the meat supply of Great Britain is imported and 48·5 per cent. home produced, Ireland being considered an importing country. Lard is not included in this list. It is given with imitation lard in Group 7, "Other Foods."

(4) *Fish: (a) Fresh, (b) Cured and Preserved.*—The fresh fish included herrings, cod, ling, haddock, mackerel, whiting, pollack, salmon, eels and congers, turbot, other flat and miscellaneous fish. Oysters and shell-fish were omitted. The cured and preserved fish included sardines, salmon, other sorts canned, and other sorts not canned. After making allowance for fish exported, the following are the net supplies:—

Fresh fish		Cured fish		Total
12,692,530 cwts.	...	591,802 cwts.	...	13,284,332 cwts.

(5) *Dairy Products, etc.*—This group includes butter, cheese, milk and cream, condensed milk, eggs, and margarine. The following are the quantities:—

	Net imports	Home produce	Total
Butter	4,834,722 cwts.	690,000 cwts.	5,524,722 cwts.
Cheese	2,207,459 cwts.	573,000 cwts.	2,780,459 cwts.
Milk and cream	63,710 gals.	802,439,000 gals.	802,502,710 gals.
Condensed milk	1,113,087 cwts.	—	1,113,082 cwts.
Eggs	24 609,266 gt. hunds. ...	9,494,084 gt. hunds. ...	34,103,350 gt. hunds.
Margarine	814,854 cwts.	881,000 cwts.	1,695,854 cwts.

There are reasons for believing that the quantity of home-produced cheese given in this list (as taken from the agricultural returns) is considerably below the actual consumption. The returns do not give any estimate of the farm produce consumed by the agricultural population. The home supply of eggs is also below the actual, since the returns do not include produce from farms below one acre. It is estimated that one-third of the total eggs are supplied by small poultry-keepers. Taking the quantities in the table above, it would appear that the home produce of butter from Great Britain, excluding Ireland, furnishes only 12·5 per cent. of the total supply, that of cheese 21 per cent., that of eggs 28 per cent. It is certain, however, that these two last estimates of home supply are well under the mark, and if the whole in each case were included, it is probable that the home supply of cheese consumed would be 35 per cent. and of eggs 42 per cent. of the total. Taking the home supply, however, even at these last values, it is not consoling that we have to rely so much on imports for what could apparently be produced without difficulty at home, in much larger quantities than at present.

(6) *Fruit: (a) Fresh, (b) Dried and Nuts.*—Of fresh fruit the returns give the quantities of apples, pears, oranges, lemons, bananas, plums, cherries, small fruit, other kinds and nuts. The following are the total supplies:—

Net imports		Home produce		Total
16,810,154 cwts.	...	6,044,250 cwts.	...	22,854,404 cwts.

Of this total, apples, oranges, and bananas make up three-fourths, and approximately in equal quantities. Of the home supply, apples make up two-fifths, but this does not include apples used for making cider.

The list of dried fruits and nuts includes currants, raisins, figs, dates, fruit preserved with sugar, almonds, coconuts, Brazil nuts, and walnuts. The total

[1] Abridged from a communication to the Royal Dublin Society, October 26, 1915, entitled, "A Calculation of the Food Stuffs and Energy of Great Britain's Food Supply."

quantity amounts to 3,057,789 cwts., of which currants make up one-third and raisins one-fifth.

(7) *Other Foods.*—In this category are included sugar, glucose, molasses, caramel, cocoa, chocolate, and olive oil. The following are the quantities :—

	cwts.		cwts.
Sugar	27,718,420	Cocoa and chocolate	549,050
Glucose (as dry sugar) ...	1,836,820	Lard and imitation lard	2,570,664
Molasses	2,199,51[illegible]	Olive oil	82,800
Caramel ...	149,000		

The "Food Values" of the Supply.

When the food values—that is to say, the foodstuffs and energy values—of the previous supplies are reckoned out, it is found that for the year 1908 the population of Great Britain (40,200,000) was provided with the following amounts, of which the particulars are given in Table I. :—

Protein (lbs.)	Carbohydrate (lbs.)	Fat (lbs.)	Energy value (kilo-litre calories)[2]
2,419,166,767	14,175,125,520	3,231,594,600	44,820,291,359

and avoid duplication in allocating the supplies, it was assumed that those engaged in agriculture, together with their families, were self-provided with most of the foods grown on the farms. Accordingly, the foodstuffs and energy derived from the following list of farm produce were distributed, not amongst the whole population, but amongst those left after the agricultural population had been deducted. This list included :—(1) Vegetables (namely, potatoes, onions, cabbage, root crops, green peas, and beans); (2) dairy produce (namely, butter, cheese, milk, cream) and eggs; (3) oatmeal and barley flour; (4) poultry, game, and rabbits; (5) certain fruits (namely, apples, pears, plums, cherries, together with one-third of the small fruit).

The food values reckoned out for those articles and divided amongst the balance of the population left, after deducting for the agricultural population, are as follows :—

Protein (lbs.)	Carbohydrate (lbs.)	Fat (lbs.)	Energy value (kilo-litre calorie)
728,697,739	2,835,356,188	1,083,718,635	11,492,106,905

TABLE I.—*The Foodstuffs and Energy Value of the Supplies.*

Food cwts.	Protein (lbs.)	Per cent. of total	Carbohydrate (lbs.)	Per cent. of total	Fat (lbs.)	Per cent. of total	Energy value Kilo-litre calories	Per cent. of total
Cereals	812,319,670	33·57	7,691,559,440	54·26	166,164,825	5·14	16,529,418,461	36·87
Vegetables ...	254,084,030	10·50	2,063,138,585	14·55	25,619,770	0·80	4,536,494,297	10·12
Meat	765,107,322	31·62	2,000,630	0·01	1,522,946,045	47·14	7,864,180,633	17·55
Fish	122,922,445	5·08	—	—	21,039,865	0·64	331,774,867	0·73
Dairy produce, etc.[3]	419,152,920	17·35	470,009,535	3·32	1,445,040,540	44·72	7,865,591,882	17·56
Fruit—								
(*a*) Fresh ...	14,390,455	0·59	285,095,825	2·01	7,031,610	0·22	597,242,464	1·33
(*b*) Preserved and nuts ...	12,368,895	0·51	166,588,475	1·17	17,603,390	0·54	458,507,190	1·02
Other foods ...	18,821,030	0·78	3,496,733,030	24·68	26,148,555	0·80	6,643,081,565	14·82
Total ...	2,419,166,767	100·00	14,175,125,520	100·00	3,231,594,600	100·00	44,826,291,359	100·00
Divisible into :								
(*a*) Agricultural	728,697,739		2,835,356,188		1,083,718,635		11,492,106,905	
(*b*) General ...	1,690,469,028		11,339,769,322		2,147,875,965		33,334,184,454	

To obtain a proper conception of the adequacy of the supplies, these totals have to be divided, not by the whole population, but by the man-value of the population. It is obvious that children, according to age, require varying quantities of food—that is to say, different fractions of a man's ration. Likewise, women consume less food as a rule than men. Standards have therefore been fixed by which the food requirements of the women and children of a mixed population, can be reduced to man values. Of these, the standards given by Atwater are generally adopted, and are so widely known that it is unnecessary to repeat them here. They were followed, so far as the census returns allow, in determining the man value of the population of Great Britain, for the purpose of this survey, except in one particular. Atwater does not begin to give a full man's ration to boys or a full woman's ration (0·8 of a man's) until the age of seventeen is passed. In the computation here made, full rations were allocated to all above the age of fifteen. On this basis the population of Great Britain in 1908 corresponded to 30,955,000 men. But this number had to be further subdivided.

In the returns of agricultural produce, as already stated, no account is taken of farm produce consumed by the agricultural population. To meet this difficulty

The remaining quantities were distributed amongst the whole population per *man*. These are :—

Protein (lbs.)	Carbohydrate (lbs.)	Fat (lbs.)	Energy value (kilo-litre calories)
1,690,469,028	11,339,769,322	2,147,875,965	33,334,184,454

This mode of distribution—at best an approximation, but the most accurate at present available—involved a calculation of the agricultural population, and then its reduction to man value. Various estimates of the agricultural population have been made, some of which the writer considers excessive. An independent one, made for this survey, and based mainly on the census returns, placed the number in 1908 at 5,304,691, with a man value of 4,260,000. Deducting the latter figure from the total man value of the population—30,955,000—leaves a general population of 26,695,000.

A computation on these lines gives the following ration per *man* per day, for the population of Great Britain :—

	Protein (grms.)	Carbohydrate (grms.)	Fat (grms.)	Energy value (litre calories)
(*a*) Agricultural supplies	33·91	131·99	50·44.	1,179
(*b*) General supplies ...	67·79	455·13	86·06	2,950
Total	101·70	587·12	136·50	4,129

The Daily Ration in Terms of Food.

The actual sources from which the foregoing foodstuffs and energy are derived are shown below. This

[2] The ordinary calorie used for expressing the energy value of a food represents the heat required to raise a litre of water from 15° to 16° C. This proved an inconveniently small unit for expressing values of the magnitude of a nation's food supply. Accordingly a unit 1000 times as great, and called here the kilo-litre calorie, is used for the most part throughout.

[3] Eggs, margarine, lard and imitation lard are here included in this group.

list of foods and quantities may therefore be taken as the British daily ration, provided by the total supply, as given in available returns:—

TABLE II.—*The Daily Food Ration of Great Britain.*

	Quantity (oz.)	Protein (grms.)	Carbohydrate (grms.)	Fat (grms.)	Energy value (grms.)
Flour and meal ...	14·55	32·80	311·10	6·80	1,476
Meat...	8·17	30·91	0·10	61·34	699
Fish	2·11	4·83	—	0·83	29
Vegetables: Potatoes	15·54 / 4·74	11·44	95·22	1·15	461
Dairy products:					
Milk and cream ...	0·66 pt.				
Condensed milk ...	0.37 oz.	16·65	221·54	45·25	588
Butter	1·02 ,,				
Cheese	0·51 ,,				
Lard and margarine	0·08 ,,	0·90	—	17·18	162
Eggs (2·94 per wk.)	0·74 ,,	2·46	—	1·93	29
Sugar, ordinary ...	4·40 ,,	0·23	139·30	—	572
Glucose and treacle	0·64 ,,				
Fruit, fresh	3·85 ,,	0·60	12·17	0·29	56
Fruit, preserved and nuts	0·48 ,,	0·43	6·68	0·70	41
Cocoa and chocolate.	0·09 ,,	0·45	1·01	0·67	13
Olive oil	0·01 ,,	—	—	0·36	3
Total		101·70	587·12	136·50	4,129

That is to say, the daily supply of food per *man* in Great Britain as above shown consists in round numbers of 14½ oz. of flour and meal, 8⅙ oz. of some form of flesh meat, 2 oz. of fish, 15½ oz. of potatoes, 4¾ oz. of other vegetables, two-thirds of a pint of milk, 1 oz. of butter, ½ oz. of cheese, ⅓ oz. of condensed milk, ⅘ oz. of lard and margarine, less than half an egg, 3⅘ oz. of fresh fruit (such as apples, pears, oranges, bananas, etc.), ½ oz. of dried fruit, $\frac{1}{10}$ oz. of cocoa, and $\frac{1}{100}$ oz. of salad oil.

But the published returns do not include the full home supply of cheese, eggs, rabbit, meat, or poultry, and probably also of cabbage used as human food. Additions to cover these omissions bring up the daily ration of meat to 8¼ oz., of vegetables to 5¼ oz., of cheese to ⅝ oz., and the supply of eggs to 3·34 per week. The food and energy value of the ration would thus be increased as follows:—

Protein (grms.)	Carbohydrate (grms.)	Fat (grms.)	Energy value (litre calories)
104·47	587·84	138·94	4,169

As a fair estimate, it would be safe to say that the gross values of the British daily food ration per *man* do not exceed the following, namely:—

Protein (grms.)	Carbohydrate (grms.)	Fat (grms.)	Energy value (litre calories)
105	590	140	4,190

The marked feature of this ration is the large quantity of fat. But a careful revision of all the sources of this foodstuff, and of the calculations upon which the total supply is based, only confirms the estimate. Moreover, the fat supply in the German daily food ration before the war, as published by the Eltzbacher Committee, is almost identical, and the ration as a whole corresponds closely with that of Great Britain. The German ration in the report of the committee is expressed in quantities per head of the population, and includes alcoholic drinks, which are left out of the present survey.

Deducting for these, and giving the quantities per *man* per day, the gross values of the ration are as follows:—

Protein (grms.)	Carbohydrate (grms.)	Fat (grms.)	Energy value (litre calories)
117·6	660·5	136·3	4,428

The values of the German ration are for food as produced or delivered at the port; those of the British ration, as here stated, are in the main the same. To get the values as purchased by the consumer, a deduction has to be made for loss in distribution. This is placed between 5 and 10 per cent. Taking it as 7·5 per cent., and deducting from the highest of the estimates, the values of the British ration "as purchased" are:—

Protein (grms.)	Carbohydrate (grms.)	Fat (grms.)	Energy value (litre calories)
97·13	545·8	129·5	3,875

On comparing the British ration with accepted standards for moderate and hard work, it is found to give an energy value between the two. Dr. Langworthy places the values "as purchased," for moderate work, at 115 grams of protein, with sufficient other food to give 3800 litre calories. Taking the mean of four standards for hard work, namely, Playfair's for English labourers, Gautier's for French labourers, Atwater's for American operatives, and Colonel Melville's for soldiers on active service, the values come out to be: protein 145 grams, with sufficient other food to give 3900 calories. The protein in these standards is considerably higher than in the British ration. But there is no disadvantage—probably the reverse—in reducing the intake of protein provided the calorie value is kept up.

Dealing with the possibility of economy in the British ration, it will be seen that the values arrived at—assuming this survey to be correct—afford no evidence of excessive supply or of waste of food. The quantity provided per man per day is just sufficient for fairly hard work. The distribution is, of course, never even; the well-to-do get somewhat more than their share, the poor less.

But the great bulk of the population—the middle classes—appear to get no more than enough to do their work, and any reduction in the total food energy would endanger the health and strength of the working man.

Where, then, is economy to come in? The answer is: (1) in substituting vegetable foods, rich in protein, such as oatmeal, peas, lentils, and beans, for part of the more costly meat supply; (2) in teaching those who have not this knowledge the great value of such foods, and how best to cook them; and (3) in the exercise of strict economy and thrift to prevent waste and make the fullest use of every article of diet. These lessons I find are admirably inculcated in a pamphlet issued by the Board of Education, entitled "Economy in Food" (Circular 917). The results of this inquiry strongly emphasise them.

A change in the directions indicated would have other useful effects also. Demand and supply reciprocally act on each other; demand creates supply, and supply influences consumption. This applies just now, more particularly, to agricultural produce. There can be no doubt, and the fact needs reiteration, that *the arable land of the United Kingdom is not used to the best advantage in the matter of food production.* The writer has elsewhere[4] pointed out that the yield of food per statute acre is far less if employed to graze cattle and sheep than if used for growing grain, potatoes, or other vegetable foods. A calculation based on average results placed the yield per statute acre in beef or mutton at 260 oz. of protein and 290,000 litre calories of energy. The same area of land furnishes, in potatoes seventeen times as much protein and thirty times as much food energy; in oats eighteen times as much protein and fourteen times as much food energy; in wheat nineteen times as much protein and fifteen times as much food energy; in beans twenty times as much protein and nine times as much food energy; in peas ten times as much protein and

[4] "Food Values." Dublin: Dollard and Co., 1915.

four times as much food energy. Even in the yield of flesh meat the advantage is on the side of tillage. More stock can be fed and more meat produced by tillage. This is particularly shown in the case of pig meat. The produce of an acre of land provides, as pork or bacon, nearly five times as much protein and seven times as much food energy as if the land were used for grazing sheep or cattle.

W. H. THOMPSON.

HARVARD CONTRIBUTIONS TO PHYSICS.

VOL. II. of "Contributions from the Jefferson Physical Laboratory of Harvard" consists of reprints of eighteen papers which have appeared in the *Physical Review* and elsewhere during the years 1913–14. The research work which these papers represents was largely aided by the Coolidge and other funds for original research. Dr. Bridgman's high-pressure work occupies a large share of the volume. We have already noticed in these columns his paper on the technique of high-pressure experimenting. From his other papers in the present volume it seems now clear that the melting points of solids continue to rise as the pressure is increased to 12,000 kilos. per sq. cm. at a rate which shows no sign of the existence of maximum melting points or of any critical points in the melting-point curves. Of the late Prof. B. O. Peirce's work on the magnetisation of short cylinders we gave an account some time ago. Prof. H. C. Hayes shows that a rate-flow meter for fluids depending on the difference of pressure at the centre and side of a vortex can be constructed to give results correct to within 1·5 per cent. Mr. J. Coulson describes an apparatus for reproducing and measuring very short intervals of time depending on the difference of time an elastic wave takes to pass from a point near the middle of a rod to the two ends. Prof. Lyman has investigated the arc and spark spectra of mercury in the region from $\lambda = 1870$ to 1270, and has found that the positions of the lines do not agree with the predictions of Hughes from photo-electric data. In the theoretical field, Prof. Hall shows that the phenomena of thermo-electricity seem to be due to free electrons, but that electric conduction seems to a large extent independent of them. Prof. Webster concludes that the phenomena of radiation, of optics, and of photo-electricity can be explained, without discarding the classical dynamics, by the aid of the Parson magneton—a ring of electrons of diameter one-tenth that of a hydrogen atom moving round its axis with the speed of light. From these short notes it will be seen that the volume constitutes a record of research of which any university may be proud.

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MEDICAL SCIENCE.

F. Alcan (Paris).—Les Maladies de l'esprit et les Asthénies, Dr. Deschamps; Thérapeutique de la circulation, Sir Lauder Brunton, French translation by Dr. A. Françon; Théorie de la contre-évolution, Dr. Larger; Le Thorax et l'Emphysème, Dr. Douay, illustrated; Méthode de traitement des fractures, Prof. P. Delbet and collaborators, illustrated; Manuel de

psychiatrie, Dr. R. Pierrac, new edition; Manuel d'électrothérapie et d'électro-diagnostic, Dr. Albert-Weill, new edition, illustrated. *J. and A. Churchill.*—Surgery in War, Major A. J. Hull, with an introduction by Lieut.-Col. E. M. Pilcher, illustrated. *W. Heinemann.*—A Text-Book of Nervous Diseases, Dr. R. Bing, translated by Dr. C. L. Allen, illustrated; Pathological Lying, Accusation, and Swindling: A Study in Forensic Psychology, Dr. W. Healy and M. T. Healy; The Practitioner's Pocket Pharmacology and Formulary, Dr. L. Freyberger; Medical Ethnology, Dr. C. E. Woodruff; and new editions of A Text-Book of Operative Dentistry by various authors, edited by C. N. Johnson, illustrated; Emergency Surgery, Dr. J. W. Sluss, illustrated. *John Lane.*—Vivisection, Hon. S. Coleridge. *H. K. Lewis and Co., Ltd.*—Localisation by Roentgen Rays and Stereoscopy, Sir J. Mackenzie Davidson, illustrated; The Pathology of Tumours, Dr. E. H. Kettle, illustrated; Essays on Practical Medicine, Dr. T. B. Scott, with a preface by Sir Lauder Brunton; Notes on Faradism and Galvanism, Dr. Magill, illustrated; The Adolescent Period: its Features and Management, Dr. L. Starr; Mentally Deficient Children, Dr. G. E. Shuttleworth and Dr. W. A. Potts, illustrated, new edition; Gould's Pocket Medical Dictionary, new edition; Diseases of the Nose and Throat, Dr. H. Tilley, new edition; and a new and revised Medical Dictionary. *J. B. Lippincott Company.*—A Text-Book of Physics and Chemistry for Nurses, Drs. A. R. Bliss, jun., and A. H. Olive, illustrated. *Longmans and Co.*—The Endocrine Organs: an Introduction to the Study of Internal Secretion, Sir E. Schäfer, illustrated; The Involuntary Nervous System, Dr. W. H. Gaskell, illustrated; The Physiology of Reflex Action, Dr. C. S. Sherrington; The Conduction of the Nervous Impulse, Dr. K. Lucas; The Physiological Basis of the Action of Drugs, Dr. H. H. Dale; The Secretion of Urine, Dr. A. R. Cushny; The Nature of Muscular Movement, Dr. W. M. Fletcher; The Cerebral Mechanisms of Speech, Dr. F. W. Mott; Tissue Respiration, Dr. C. L. Evans ("Monographs on Physiology"). *Methuen and Co., Ltd.*—The Care of the Body, Dr. F. Cavanagh; The Care of the Teeth, A. T. Pitts; The Eyes of our Children, N. B. Harman; The Health of the Skin, Dr. G. Pernet; How to Live Long, Dr. J. W. Carr, The Prevention of the Common Cold, Dr. O. K. Williamson ("Methuen's Health Series"). *The Oxford University Press.*—The Evolution of Modern Medicine, Sir W. Osler. *Kegan Paul and Co., Ltd.*—Nervous Disorders of Men, Dr. Bernard Hollander; Nervous Disorders of Women, Dr. Bernard Hollander; Abnormal Children, Dr. Bernard Hollander.

TECHNOLOGY.

Cassell and Co., Ltd.—Drawing and Design for Craftsmen, R. S. Bowers; Electric Bells and Telephones, illustrated; Workshop Hints for Munition Workers, illustrated; Electric Lighting, A. H. Avery, illustrated ("Work" Handbook Series). *The Electrician Printing and Publishing Co., Ltd.*—The Theory of the Submarine Cable, Dr. H. W. Malcolm; Electric Switch and Controlling Gear, Dr. C. C. Garrard; Electric Measuring Instruments: their Design, Construction, and Application, Dr. C. V. Drysdale and A. C. Jolley; Electric Hoists and Lifts, G. Rowe; The Localisation of Faults in Electric Light Mains, F. C. Raphael, new edition; Primary Batteries: their Construction and Use, W. R. Cooper, new edition; Secondary Batteries: their Manufacture and Use, new edition. *Crosby Lockwood and Son.*—The Manufacture of Earthenware, E. A. Sandeman, illustrated; Munition Workers' Handbook, E. J. Pull, illustrated. *Kegan Paul and Co., Ltd.*—Flour-Milling, Dr. P. A. Kozmin, illustrated. *G. Routledge and Sons, Ltd.*—Painters' and Decorators' Work, H. G. Dowling, illustrated ("Broadway Text-books of Technology"). *Whittaker and Co.*—Telegraphy, T. E. Herbert. *John Wiley and Sons, Inc. (New York), and Chapman and Hall, Ltd.*—The Canning of Fruits and Vegetables, J. P. Zavalla.

MISCELLANEOUS.

F. Alcan (Paris).—La Science et savants germaniques, edited by Prof. Gabriel Petit. *Baillière, Tindall, and Cox.*—Analytical Psychology, Prof. Jüng, translated by Dr. C. Long, illustrated. *H. Holt and Co. (New York).*—First Course in General Science, Prof. F. Barber and colleagues. *Macmillan and Co., Ltd.*—Discovery: or the Spirit and Service of Science, Prof. R. A. Gregory; The Statesman's Year Book, for the Year 1916, edited by Dr. J. Scott Keltie, assisted by Dr. M. Epstein. *The Open Court Company.*—The Contingency of the Laws of Nature, E. Boutroux, translated by F. Rothwell; The Collected Logical Works of George Boole, vol. ii., containing The Laws of Thought; The Early Works of Diderot (Letters on the Blind and on Deaf-Mutes, etc.), translated and edited by M. Jourdain ("Open Court Classics of Science and Philosophy"). *The Oxford University Press.*—Sadoleto on Education, a translation of the "De pueris recte instituendis," with notes and introduction by Prof. E. T. Campagnac and K. Forbes; Sir Walter Raleigh: Selections from his "History of the World," Letters, and other Writings, edited, with introduction and notes, by G. E. Hadow; A Documentary History of Yale University, F. B. Dexter; Architectural Acoustics, W. C. Sabine; A Study of the Economic Life of a Bengal District, J. C. Jack. *Kegan Paul and Co., Ltd.*—The British Coal Trade, Prof. H. Stanley Jevons, illustrated. *T. Fisher Unwin, Ltd.*—Instincts of the Herd in Peace and War, W. Trotter.

THE ORGANISATION OF SCIENTIFIC RESEARCH.[1]

AMONGST the indirect results of this appalling war, we may hope that there will be some increased appreciation in the minds of the politicians who govern us of the enormous influence of scientific research and discovery, even in its most abstruse forms, on the prosperity and safety of the Empire. We have had brought home to us that this war is a war quite as much of chemists and engineers as of soldiers and sailors. Hence, from the point of view of national security alone, we must take steps to foster scientific investigation. We shall probably never succeed in convincing the unthoughtful multitude of the manner in which the highest scientific researches affect human life in innumerable ways, but it will be sufficient if that fact is brought home to the consciousness of those who have political position and power, and if we can impress upon them that theirs will be the responsibility if they neglect to encourage it.

Methods of Scientific Research.

The great bulk of all our scientific discovery and research in the past has been due to individual labour and initiative; much of it a labour of love, unrecognised at the time. Men of great genius have opened up new lines of thought or pursued private researches often with very inadequate appliances. In fact, the greater part of past British scientific research may be said to have been amateur work, not in the sense that

[1] Abridged from a paper read before the Royal Society of Arts on February 9, by Prof. J. A. Fleming, F.R.S.

it was lacking in the highest qualities, but only in the sense that it was pursued for the sheer pleasure and interest of it by private individuals. It was done mostly at odd times, and nearly always at the worker's own expense.

The point seems to have been reached at which the first attempt to organise research should be to create something more resembling an army out of the multitude of independent scientific workers. An army is not a collection of armed individuals, each pursuing his own aims and ideas. It is a complex organism in which each man has place and duty. No great enterprise can be carried out unless there is some degree of surrender of initiative and acceptance of directions from a higher command. To carry out this principle in scientific work we require to a fuller extent than we have it at present the system of scientific work done to order. This means that young investigators, and even the older, shall be content to take up pieces of prescribed work, quantitative or qualitative, and carry it out individually or conjointly in connection with certain large plans of operation.

This conjoint or co-operative work would have several advantages. It would save much reduplication, and it would train beginners in the best methods of research. It would effect a saving of time and enable us much more quickly to reach a given point. There is much plain and straightforward research which can be carried out when its general lines are indicated to those not possessing very great originality, but yet having perseverance, accuracy, and skill.

If, however, such work is to be undertaken by those who may perhaps be called the privates and non-commissioned officers of the scientific army, then it presupposes a directing power which shall supply what I have elsewhere called the strategy of scientific research. This must, of course, come from the more experienced and able workers, and it is to them that we must look for ideas. If some men are to surrender initiative in their work, then others must give time and thought to planning the outlines of the scientific campaigns.

We need not only the regimental officers but the General Staff if there is to be effective achievement. My contention is that this specification of the main lines of suggested research is a matter which should largely occupy our learned societies, and in particular the Royal Society, from its broad and general character and unique position.

But something more than this is necessary. We have to formulate in precise detail the suggestions for future work, and bring them to the notice of those who may be able or willing to work them out. The White Paper, which was issued last July by the Board of Education, signed by Mr. Arthur Henderson, seems intended to bring into existence some machinery for effecting this desired end. So far as the "Scheme for the Organisation and Development of Scientific and Industrial Research" outlined in this White Paper is formulated in detail, it appears to consist in the establishment of (i) a committee of the Privy Council, which will be responsible for any expenditure voted by Parliament for scientific and industrial research; and (ii) a small advisory council, composed mainly of scientific men and men actually engaged in industries dependent upon scientific research.

The primary functions of the advisory council are stated to be to advise on:—(1) Proposals for instituting specific researches; (2) proposals for developing or establishing special institutions for the study of problems affecting particular industries; (3) the establishment and award of research studentships and fellowships.

The White Paper tells us that it is contemplated that the advisory council will work largely through sub-committees reinforced by suitable experts in the particular branch of science or industry concerned on which it would be desirable to enlist the services of persons actually engaged in science, trades, or manufactures.

It is clearly impossible for any single board composed of a few men, however eminent, to deal in any reasonable time with all the research problems awaiting solution in physics, chemistry, inorganic, organic, and technical, metallurgy, engineering, electrotechnics, bacteriology, agriculture, etc., and the questions concerned in the recovery of our trade in dyes, drugs, glass, ceramic ware, ferro-alloys, and scientific apparatus.

Hence separate bodies of experts will unquestionably be required to deal with the different subjects in order to bring to bear upon them the proper technical knowledge and to guide research on the right lines. But now, if this is the case, the question at once arises: Why is it necessary to create a new machinery for dealing with these matters? Have we not already in the councils of our learned and technical societies, or in committees of their members, all that is required to form these boards, which might be called Permanent Advisory Committees on scientific research? Why is it considered necessary to create new committees?

The proposition I submit for your consideration is that the organisation of scientific research should be a matter undertaken by scientific men themselves, and should not be taken over independently of them by a Government Department. The essential matter is that this organisation of scientific research should not become bureaucratic or academic, but should be conducted by bodies represenative of the best technical and scientific opinion, and be closely in touch with the members of all the various scientific and technical societies. If these permanent advisory committees in the different subjects were elected from the councils or members of the various societies, we should have in them men who are closely in touch with those particular branches of pure or applied science.

If public funds are to be administered, then it might be proper that certain of the members on each board should be appointed by the Government Department concerned, say, by the Board of Education; but my contention is that the organisation work should be the work of scientific men as a whole and not any small section of them, or be carried out by Departmental officials over their heads.

Suppose, then, we assume that we have created permanent advisory committees for the different branches of pure and applied science, the duty of which should be the organisation of research in their respective departments. Their first work should be to draw up as comprehensive a report as possible, pointing out the general needs of each department of knowledge and the most necessary directions of research in it.

The first report would no doubt have to be concerned chiefly with the deficiencies in the appliances and means of conducting it, such as laboratories and apparatus. Also with the numbers and supply of men available for undertaking it or actually engaged on it. Later reports would then be properly occupied with the more detailed discussion of the problems awaiting investigation and particular suggestions for directions of research. Each advisory board should have its salaried recorder or secretary, who should be a scientific man with some literary attainments. Each board should, of course, have taken evidence from all kinds of experts in its own subject in drawing up its report, so that this document would then be not the mere embodiment of the opinions of a few, but the concentrated wisdom of all those engaged in

the same field of work. Such reports, if made annually, would come to possess immense value and form a solid basis for suggested practical reforms.

It has sometimes been suggested that the State should make pecuniary rewards for scientific discoveries or inventions, but this is not a very practicable proposal. It is extremely difficult in most cases to appraise the value of a scientific discovery or invention in its early years, and in the next place there are pieces of scientific work the real value of which does not appear until long after the death of the originator.

Who, for instance, could have set a value on Faraday's discovery of induced currents or magneto-electric induction, when in ten days of intermittent work at the Royal Institution in the autumn of 1831 he gathered in new knowledge of surpassing importance to mankind? These facts had no apparent value at the time, yet their application has brought wealth in untold millions into the exchequer of nations.

I remember speaking, shortly after Clerk Maxwell's death in 1879, with an eminent Cambridge mathematician concerning Maxwell's great paper published in 1865 "On the Dynamical Theory of the Electromagnetic Field." He told me in all seriousness that the impression produced on his mind by this great paper was that it was one of the most exalted productions of the human intellect. Yet it was twenty years, and long after Maxwell's death, before this paper brought forth its fruit in Hertz's work, and thirty-five years before we saw the final outcome of it in the achievements of wireless telegraphy.

How would it have been possible for contemporaries properly to give a value to that suggestive paper in terms of current coin? I believe the only practical method of assisting scientific research is by a well-devised system of research scholarships, fellowships, and professorships renewable annually or at longer intervals, and in any case held subject to productive work.

If we combine such a system with the above suggested advisory boards, there is a possibility of creating a workable system for the endowment and encouragement of scientific investigation which will be kept in close contact with practical necessities as well as with the most fertile regions of scientific thoughts.

Provision of the Means for Conducting Scientific Research.

One rather startling experience at the outset of this great war was the discovery of the extent to which we had become dependent on Germany and Austria for these implements of research. We found that our sources of supply of chemical glass such as flasks, beakers, tubes, graduated vessels, and more complicated pieces of analytical apparatus was cut off. Also porcelain crucibles, basins, tubes and retorts, filter papers, and large numbers of research chemicals were not produced in England of the requisite quality.

Amongst pharmaceutical chemicals a very large number have been unobtainable, or obtainable with difficulty, since the war—such as salicylates, salvarsan, veronal, and phenacetin. My colleague, Prof. Cushny, informs me that all the more complex synthetic chemicals, such as those used as indicators, stains in microscopic work, etc., have been obtained from Germany and are now unobtainable.

In physical and electrical work there has also been the same difficulty. Before the war we obtained many necessary materials from Germany which ought to have been made here. I instance such things as types of electric resistance furnaces for laboratory and assay work. Kathode ray oscillographs and the proper type of electrostatic influence machines for working them. Certain types of mechanical pumps for making high vacua. Extremely fine wires of different materials necessary for thermo-electric ammeters for high-frequency current measurements in wireless telegraphy, and also special alloy wires for electrical resistances, and many other similar materials.

We were at one time even entirely dependent on Germany and Austria for electric arc carbons, and only the enterprise of one British firm saved the situation. We are even now in difficulties as regards some electric fittings and appliances.

As an instance of the way in which the Germans look forward and anticipate the future, we may note the case of tungsten ore. When, after prolonged scientific researches, the metallic filament electric lamp made with drawn or pressed tungsten wire had ousted the carbon lamp, and when the immense importance of tungsten-steel had been recognised for high-speed tools and magnet manufacture, German interests set to work to secure the control of sources of supply of tungsten, even within the British Empire. One of the chief sources of supply of wolframite, an ore from which tungsten is obtained, is in Burma, which produces about one-fifth of the world's supply. Before the war the Germans used to secure nearly all this ore and carry out the reduction in Germany. Consequently, when the war broke out there were few or no reduction works in England capable of supplying tungsten or ferro-tungsten.

In spite of this extremely valuable tungsten supply in Burma, which is the largest mineral-producing province of India, the local government was not provided with any mining expert who could have advised them in this matter.

It is satisfactory to note, however, that steps have been taken to remedy the state of affairs. The Lieutenant-Governor, Sir Harcourt Butler, visited Tavoy, the centre of the industry, last December and addressed the Chamber of Mines. He urged the concessionnaires to do all that was possible to obtain the wolframite required at present for the making of munitions, and represented that if private owners did not meet the British demand, concessions would be cancelled and the Government would take possession. Nevertheless, the Germans have provided themselves with large stocks of this valuable material already, without which it is impossible to make modern high-efficiency incandescent electric lamps or high-speed cutting tools for engineering work. This is only one out of many instances which might be quoted to show our extraordinary want of scientific foresight in allowing absolutely essential materials to be taken by Germany both before and during the war.

This partial famine in essential scientific materials and apparatus is not due to any real want of scientific ability on the part of British inventors or manufacturers. It is due to causes which are very deep-seated. For one thing, our easy-going national temperament has found it less trouble to buy from abroad than make for ourselves. Labour difficulties, our fiscal policy, and other causes have rendered it difficult to compete with German prices.

Above all, the mistakes and ignorance of politicians who allowed themselves and others to believe that there was no real danger of a rupture of peace, and that Germany's tremendous preparations for war had no other object than defence against sudden attack by jealous neighbours, acted like an opiate on our spirit of commercial enterprise and dulled our instinct of self-preservation. Meanwhile, it is to be hoped we are now awake to facts, and that scientific men, manu-

facturers, and our statesmen will unite in remedying the present serious condition of affairs.

Now the question is: Are we going back, when peace returns, to the old easy-going habits of importing German-made scientific apparatus? Surely the answer is, No! a thousand times No! But unless we wish Germany's crime-stained hands to take back in commerce what she has lost in war, we have to create and maintain an entire scientific and economic independence of our own. For this purpose we need, for one thing, a properly-complete Scientific Intelligence Department.

The different agencies, committees, and institutions which have been endeavouring to supply scientific information as to manufactures should have as their resultant a single organisation, the function of which should be to collect and distribute all possible information concerning the mode of manufacture and cost of production and information concerning the patent position, if any, of all the appliances and materials used in scientific research. Such a scientific intelligence and information bureau might need subsidising at the start, but it might be possible later on to make it self-supporting by the subscriptions of firms and persons who desired information on particular matters. Just as one can pay a fee to a patent agent to conduct a search for anticipations on some particular subject, so this information bureau should have as its object to collect and supply to its subscribers all possible information concerning the manufacture or supply of the materials and implements of scientific research. This bureau might have certain laboratories or workshops attached to it where information could be tested and specifications issued for the manufacture of the materials and appliances used in research. It should not be concerned either with actual trade manufacture or with researches *per se*, but should enable anyone to find out with the least expenditure of time the exact way in which certain scientific materials or instruments are made and under what conditions they can be produced, and to supply this information to the trades concerned who are its supporters or subscribers.

Training of Men to Conduct Scientific and Industrial Research.

Whilst the highest achievements in scientific research and invention must always depend to a great extent on that indefinable quality we call genius which cannot be made to order, it can scarcely be doubted that much can be done to foster and assist it.

The nation must be educated to see that the men with high scientific and inventive ability in it, not by any means too numerous, constitute a national asset of inexpressible value. This power, when it exists, should not be allowed to dissipate itself in a struggle to secure the means of living, but be given an opportunity for the fullest exercise and use. There can also be no question that we have it in our power by suitable methods of education to develop such nascent ability.

Our present systems of education, and particularly the system of written examinations which are dependent so much on good memory for success, do much to destroy originality. In spite of all that has been written and said on this subject, we do not seem to be nearer to essential reforms. The object of all education is threefold: first to train character, will, and that power of selecting the best amongst various courses of action which we call right judgment; secondly, to impart necessary information and ability to do certain things well; thirdly, to develop initiative and the power of handling new problems or investigations and a certain alertness in dealing with new situations. Our present methods of education are far too much directed to supplying ready-made and peptonised information.

The great outstanding fact in modern life is the degree to which the energies and materials of Nature are employed to overcome the difficulties created by the increase and concentration of population. We have to make the earth bring forth her increase at a greater rate, to supply the ever-increasing necessities of growing populations and the many artificial wants which have been created by progressive human desires. Hence an absolutely essential part of any complete education is some knowledge of science, and especially of its influence on the welfare of mankind. Yet the people we put in a position of authority over us are, for the most part, not only ignorant of science, but not even interested in it. In our public schools we train boys chiefly by directing their attention to words in the form of the grammar and literature of two dead languages, and we neglect to give them any wide and sufficient knowledge of things—viz., the physical phenomena of the universe in which they live.

Is it, then, any wonder that when these boys grow up and take their places in Government offices, in the Law Courts or on the Press, or any other influential position, they are oblivious to the last degree of events taking place in the world of science which have in them the power to make or destroy national industries or affect the living of large populations? The destruction of the madder industry of France and the indigo industry of India by German synthetic chemistry are now old and familiar stories.

The point, however, to notice is that the scientific chemical discoveries were not allowed to remain mere laboratory feats. They were transformed into successful commercial enterprises. The Badische Anilin- und Soda-Fabrik is said to have expended 1,000,000*l.* and taken seventeen years' work in translating Baeyer's scientific synthesis of indigo into a factory process. But the result has justified the foresight of those who expended it. This is only one instance out of many which could be quoted to show the blows that can be inflicted in this industrial warfare, the weapons in which are not shot and shell, but scientific discoveries and inventions.

The supremely important question is: What are the steps we are taking to train the men who will enable us to hold our own in this commercial conflict? It avails nothing to point out that the beginnings of many of these achievements were laid by British scientific discoveries or original suggestions. A truth or a suggestion which is not followed out or pressed to the point at which it becomes practically productive is like a seed which is not planted in the ground. The intellectual perception of a truth or principle requires behind it the driving force of character and will if it is to pass into the useful stage.

Some people might be inclined to ask why there should be this competition and pressure to invent? What difference does it make who discovers a new fact or makes a new application? If scientific knowledge were a mere matter of intellectual curiosity concerning the secrets of Nature it would not matter much, except for national honour, who made the discoveries or applications. But scientific knowledge has become much more than this. It has become the means of increasing national wealth, and also by which national wealth can be taken away. Again, in virtue of our patent laws, it has become possible for alien inventors to prevent us from even using in our own country in particular ways the waste products of our own industries, as in the case of certain coal-tar products. Hence scientific knowledge can be applied so as to become a tremendous weapon of destruction as well as of national strength. It is for

this reason that we require men to be trained, not merely to make scientific discoveries, but to make useful commercial applications of them, which are wealth-producing or wealth-conserving in a national sense. This requires a peculiar combination of scientific ability and commercial insight, and it is just here that Germany has the advantage.

Mr. Lloyd George said on one occasion that he feared Germany's war-bread spirit, by which he meant the willing subjection of a whole Empire to discipline. We might say, with even more truth, that what is to be feared is Germany's militant chemistry and engineering, or that combination of commercialised science which is relentlessly applied to undermine and take away sources of power of other nations. This, however, is what we have to meet. We have to train chemists, engineers, electricians, and physicists who are not only learned in the knowledge of their science and originative in discovering new facts and principles, but have also a keen commercial sense which directs them to the solution of the practically useful problems. We have, therefore, to create a very much closer union between industry and science. To some scientific men this seems derogatory to the dignity of science. On the other hand, men concerned with the business side of manufacture are apt to undervalue the aid which science can give them. Meanwhile our scientific industries suffer from this dissociation.

In the first place we should aim at bringing about a much more intimate relation between the universities and technical colleges and the factories and workshops, so that the college teaching may result in producing a type of man more useful in the factory. For this reason I am an advocate of the so-called sandwich system, by which the student spends a year alternately in the shop or factory and in the college, the first and third year being at the college and the second and fourth in the shop or factory. This turns out a better type of man than two years at the college and two years in the shop taken consecutively. It should apply not only to engineers in all branches, but to chemists as well.

Then, again, conferences should be held from time to time between teachers and practical engineers and chemists for the exchange of ideas on the subject of the schemes of work and study to be followed by the student-apprentice, so as to turn out all-round men and not unpractical theorists or unscientific practists. We have to improve in many ways our college teaching, so as to expend to better advantage the available time and place more stress on ability to use information than to store it. Engineering and chemical students should be brought much earlier than at present into contact with questions of cost and estimates, so that they may know not only how and why a certain machine works, but what it costs to make it, or to run it. They will then be far better able to take advantage of the workshop training and obtain earlier that "workshop sense" or instinct which looks at everything from the point of view of cost and profit, as well as operation or efficiency.

We have before us a tremendous task to restore the waste of this great war. To do this we have to utilise all waste products and to abolish waste and inefficiency in all departments of life, domestic, commercial, political, and industrial, and we have to get rid of them in scientific work as well. We can only do this by bringing to bear the scientific method upon all these regions of activity and even upon scientific research itself. As a small contribution to this work the above suggestions are tentatively put forward, and with the greatest diffidence I submit them now to your careful consideration.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—A friend of the late Dr. Donaldson, master of Magdalen College, has endowed a bye-fellowship of the annual value of 100*l*., to be called the Donaldson Bye-Fellowship, in memory of the late master; the fellowship is intended for the encouragement of research, and is tenable for one year. The Financial Board reports that Sir Eustace Gurney has offered to present to the University a farming estate of about 257 acres with a view to the encouragement of the study of forestry in the University; the net income in rent of the estate is about 100*l*. per annum. The General Board of Studies reports that the council of the Royal Geographical Society has decided to make grants of 300*l*. per annum for five years to the schools of geography in Oxford and Cambridge. Mr. H. H. Brindley, of St. John's College, has been appointed demonstrator of biology to medical students, and Mr. C. Warburton, of Christ's College, demonstrator in medical entomology; both appointments are for a period of five years.

LONDON.—The following new doctorates in science are recorded in the *London University Gazette* for February 9:—*Physics*: E. J. Evans (Imperial College—Royal College of Science), for a thesis consisting of three papers on spectroscopy published in (i) NATURE, September 4, 1913; (ii) *Phil. Mag.*, February, 1915; (iii) *Phil. Mag.*, January 1916. *Organic Chemistry*: Biman Bihari Dey (Imperial College—Royal College of Science), for a thesis entitled "A Study in the Coumarin Condensation" (Trans. Chem. Soc., 1915). *Applied Statistics*: Leon Isserlis (University College), for a thesis consisting of the following papers:—(i) "On the Multiple Correlation Ratio," parts i. and ii. (*Biometrika*, November, 1914, and November, 1915); (ii) "On the Conditions under which the 'Probable Errors' of Frequency Distributions have a Real Significance" (Proc. Roy. Soc., A., 92, 1915).

A NOTE in the *Times* of February 10 states that Mr. C. E. Probyn, who died on December 1 last, left estate of the gross value of 14,563*l*., the residue of which, amounting to about 10,000*l*., is bequeathed to the University of Bristol.

WE gather from the *Münchener medizinische Wochenschrift* that of the 18,110 students inscribed during the present semester in seven of the German universities, 13,629 are absent in the army, *i.e.* slightly above 75 per cent.

DR. E. H. GRIFFITHS, principal of the University College of South Wales and Monmouthshire, who had arranged to resign at the end of the present session, has consented, at the request of the council, to continue in office until the end of the session 1917–18.

WE learn from the *Pioneer Mail* that the staff has now been selected for the Lady Hardinge Medical College and Hospital at Delhi, which Lord Hardinge opens to-day:—Principal and professor of medicine, Dr. K. A. Platt; professor of anatomy and gynæcology, Miss Hitton; professor of pathology, Miss Field; professor of anatomy, Miss Murphy; professor of chemistry, Miss A. M. Bane; professor of biology and physiology, Miss M. R. Holmer. It is expected that tuition will begin next September, and the Government of India will contribute a lakh of rupees (6700*l*.) yearly to the annual maintenance charges.

THE issue of the *Pall Mall Gazette* for February 8 contained an interesting account of an interview with Sir Philip Magnus, in which he expressed his views

on the changes desirable in the education of this country. Larger grants for scientific industrial research, though imperatively necessary, will not be enough. What our system of education should be after the war must be inquired into. Our children will have to be taught their duties as citizens of a great Empire, and in relation to our Dominions overseas. Sir Philip Magnus advocated the appointment of an independent and competent committee, such as was suggested by him in the House of Commons on January 26 (see NATURE, February 3, 639), to inquire into the whole question. Scientific education must be made more general and the spirit of our people be made scientific. Science must be given full play in all our activities, and especially must it govern our organisation. Such a committee would be able to effect concentration, and its recommendations should lead to reforms and development of the Board of Education. While it is of the utmost importance that we shall apply science to commerce, to industry, and to other purposes, it is, said Sir Philip, still more important to keep steadily in mind that the highest aim of education is so to develop the character of our people that they shall act as moral human beings.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 10.—Sir J. J. Thomson, president, in the chair.—Lord **Rayleigh**: The theory of the Helmholtz resonator. The ideal form of a Helmholtz resonator is a cavernous space enclosed in a thin immovable wall, but communicating with the external atmosphere by means of a small perforation. An approximate theory is due to Helmholtz, who arrived at definite results for apertures the outline of which is circular or elliptic. In the present paper the approximation is carried further for the special case where the wall is spherical, with the aid of the appropriate Legendre's functions.—Sir Norman **Lockyer** and H. E. **Goodson**: The oxyhydrogen flame spectrum of iron. A spectrogram of the light emitted when metallic iron burns in the oxyhydrogen flame, notably rich in lines due to the metal, has been studied. Sixty-four lines of iron have been identified in the region $\lambda\lambda\, 3856{\cdot}52 - 5615{\cdot}88$. Fifteen of these lines do not appear to have been hitherto recorded in the iron-flame spectrum, and a number of these latter possess special interest. On the basis of a comparison of the flame spectrogram with a spectrum of the iron arc of approximately similar exposure, it has been possible to separate the flame lines according to the observed variations of intensity into two well-marked groups, whilst a residuum forms an intermediate group. All the flame lines have accordingly been placed in one or other of the following three groups:—

Group A containing lines stronger in flame than arc.
„ B „ „ weaker „ „
„ C „ „ nearly equal in both sources.

This division bears close relation to the more minute classification employed by King in the case of spectra obtained at varied temperature levels in the electric furnace.—W. G. **Duffield** and M. D. **Waller**: The consumption of carbon in the electric arc. III.—The anode loss. It has already been shown that the rate of consumption of carbon from the kathode of a very short arc is such that the departure of one atom is accompanied by the transfer between the poles of four electronic charges. The above experiment gave a clue to the *rôle* played by the kathode. Experiments were undertaken to determine the part played by the anode. It appears that the anode loss of carbon is unimportant in the mechanism of the arc, and that the function of the anode is to receive the carriers of the current produced by the essential process occurring at the surface of the kathode. The formation of a crater in the normal type is not vital to the arc, though it is its most prominent feature. The reduction in potential difference in the arc with rotating anode is probably due to absence of electronic emission on a large scale from its cooler anodes.—C. H. **Lander**: Surface friction: experiments with steam and water in pipes. The work comprises a verification of Rayleigh's formula connecting resistance with velocity, density, diameter of pipe, and kinematical viscosity of fluid. The results are slightly above those obtained by Stanton and Pannell for water and air in brass pipes, and show similar characteristics. The general results of the work confirm the accuracy of the assumptions made in the derivation of the equation

$$R = \rho v^2 F\left(\frac{vd}{\nu}\right)$$

for fluids differing as widely in their properties of viscosity, density, etc., as steam and water.—T. R. **Merton**: The structure of broadened spectrum lines. It is considered improbable that the broadening of spectrum lines which occurs at high pressures and under conditions of powerful electric discharge can be referred to the movement of the atom as a whole, but rather to processes more intimately connected with the problem of radiation. Stark has suggested that the broadening is closely related to the electric resolution of the lines. On this assumption the distribution of intensity to be expected in the lines $H\alpha$, $H\beta$, and $H\gamma$ of hydrogen, broadened by powerful discharges, is discussed. A method of investigating the distribution of intensity in these broadened lines has been found. This method is not affected by the eccentricities of the photographic plate and is adapted to quantitative measurements. The results for the hydrogen lines show that $H\alpha$ consists of a strong maximum falling off rapidly and regularly on either side, $H\beta$ falls off much less rapidly and shows a minimum at the centre of the line, and $H\gamma$ shows a strong central maximum with very diffuse "wings" on either side.

PARIS.

Academy of Sciences, January 24.—M. Camille Jordan in the chair.—L. **Maquenne**: The comparison of the action of saccharose and of invert-sugar on alkaline copper solutions. Supplementing an earlier note on the same subject, details are given of the influence of temperature and time on the reduction by invert sugar and by cane-sugar.—Boris **Delaunay**: The general solution of the equation $X^3\rho + Y^3 = 1$.—Gaston **Julia**: Positive quadratic binary forms.—Maurice **Fréchet**: The deviation of any two functions.—A. **Liljeström**: The difference between the centre of gravity and centre of inertia.—G. **Mouret**: The flow of liquids over a thin edge.—Ernest **Esclangon**: The trajectories of projectiles in air.—J. **Dejust**: The determination of the rational surface of the blades of a hydraulic turbine.—M. **Mesnager**: The problem of the fixed thin rectangular plate.—Thadée **Peczalski**: The mechanical equivalent of the light of an incandescent lamp.—Stanislas **Meunier**: New observations on the structure of the meteoric irons of the Diablo Canyon (Arizona): consequences relating to the circumstances of the fall of these meteorites. The author's interpretation of the structure of the meteorite agrees with the view put forward by Barringer and Tilghmann, that the crater of Coon Butte was excavated by the shock of the meteorite (see NATURE, January 27, p. 595).—M. **Dalloni**: The Senonian of Oran (Algeria).—M. **Marage**: The measurement of the sharpness of hearing in real and simulated deafness. A discussion of the

importance of quantitative measurements of deafness in connection with the army.—P. **Bazy**: Delayed tetanus. The immunity given by the antitetanus serum lasts only fifteen days, and under certain conditions tetanus may develop as long as fifty days after infection. Injections every eight days for a month are suggested as a safeguard.—A. **Policard**, B. **Desplas**, and A. **Phélip**: Biological researches on wounds received in battle. The microbial flora and its relations with the clinical evolution and the characters of the wound.

BOOKS RECEIVED.

Anatomie des Clausilies Danoises. By C. M. Steenberg. i., Les Organes Génitaux. Pp. 44 (Kobenhavn: Bianco Lunas.)

The British Journal Photographic Almanac, 1916. Pp. 984. (London: H. Greenwood and Co., Ltd.) 1s. net.

Transactions of the Geological Society of Glasgow. Vol. xv., part 3. Pp. 297–437. (Glasgow: Geological Society.) 7s. 6d.

Mathematical Papers for Admission into the Royal Military Academy and the Royal Military College. September–November, 1915. Edited by R. M. Milne. Pp. 30. (London: Macmillan and Co., Ltd.) 1s. net.

Wisconsin Geological and Natural History Survey. Bulletin xlii. Educational Series, No. 5: The Geography of the Fox–Winnebago Valley. By Prof. R. H. Whitbeck. Pp. 105. (Madison, Wis.)

A Bird Calendar for Northern India. By D. Dewar. Pp. 211. (London: W. Thacker and Co.) 6s.

Forerunners and Rivals of Christianity, being Studies in Religious History from 330 B.C. to 330 A.D. By F. Legge. 2 vols. Vol. i., pp. lxiii+202. Vol. ii., pp. ix+425. (Cambridge: At the University Press.) 2 vols., 25s. net.

Commerce and Industry. By Prof. J. R. Smith. Pp. viii+596. (New York: H. Holt and Co.) 1.40 dollars.

Memoirs of the Geological Survey of India. Palæontologia Indica. New Series. Vol. vi. Memoir No. 1. Supplementary Memoir on New Ordovician and Silurian Fossils from the Northern Shan States. By Dr. F. R. C. Reed. Pp. vii+100+xii plates. (Calcutta: Geological Survey; London: Kegan Paul and Co., Ltd.) 4s.

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 17.

ROYAL SOCIETY, at 4.30.—The Action of Cobra Venom: Prof. A. R. Cushny and S. Yagi.—Gametogenesis and Sex Determination in the Gall-fly, *Neuroterus lenticularis*. III.: Dr. L. Doncaster.—The Structure and Development of the Skull and Laryngeal Cartilages of Perameles, with Notes on the Cranial Nerves: Philippa C. Esdaile.—Physiological Investigations with Petiole-Pulvinus Preparation of Mimosa Pudica: J. C. Bose and S. C. Das.

ROYAL INSTITUTION, at 3.—Variable Stars: Sir F. W. Dyson.

ROYAL GEOGRAPHICAL SOCIETY, at 5.—A Synthetic Method of Determining Geographical Regions: Dr. J. F. Unstead.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Kelvin Lecture: Terrestrial Magnetism: Dr. C. Chree.

ROYAL SOCIETY OF ARTS at 4.30.—The Saints of Pandharpur: C. A. Kincaid, C.V.O.

LINNEAN SOCIETY, at 5.—John Bartram; the Pioneer American Botanist: Miss C. Herring-Browne.—Acorn Producing Twin Plants: Miss M. Rathbone.—Winter and Summer Coloration of the Ermine, *Putorius ermineus*: E. S. Goodrich.—The Infestation of Bamboos in Tidal Waters by *Balanus amphitrite* and *Teredo navalis* in Tenasserim: E. P. Stebbing.

FRIDAY, FEBRUARY 18.

ROYAL INSTITUTION, at 5.30.—Polarised Light and its Application to Engineering: Prof. E. G. Coker.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Annual General Meeting.—Chisels: H. Fowler.

MONDAY, FEBRUARY 21.

ROYAL SOCIETY OF ARTS, at 4.30.—National and Historic Buildings in the War Zone; their Beauty and their Ruin: Rev. G. H. West.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—The Valley of Mexico: A. P. Maudslay.

TUESDAY, FEBRUARY 22.

ROYAL INSTITUTION, at 3.—Nerve Tone and Posture: Prof. C. S. Sherrington.

ZOOLOGICAL SOCIETY, at 5.30.—Studies on the Anoplura and Mallophaga, being a Report upon a Collection from the Society's Gardens. I.: B. F. Cummings.—Further Observations on the Intestinal Tract of Mammals: Dr. F. Chalmers Mitchell.

ILLUMINATING ENGINEERING SOCIETY, at 8.—*Discussion*: Some Future Possibilities in the Design of Instruments for Measuring Illumination (with Special Reference to Photometers Depending on Physical and Chemical Methods).

INSTITUTION OF CIVIL ENGINEERS, at 5.30.—The Main Drainage of Cairo: C. C. James.

WEDNESDAY, FEBRUARY 23.

ROYAL SOCIETY OF ARTS, at 4.30.—Serbia as seen by a Red Cross Worker: Miss H. B. Hanson.

GEOLOGICAL SOCIETY, at 5.30.—The Origin of some River-Gorges in Cornwall and Devon: H. Dewey.

THURSDAY, FEBRUARY 24.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: Mathematical Contributions to the Theory of Evolution. XIX. Second Supplement to a Memoir on Skew Variation: Karl Pearson.—The Relative Combining Volumes of Hydrogen and Oxygen: F. P. Burt and E. C. Edgar.—Speed Effect and Recovery in Slow-speed Alternating Stress Tests: W. Mason.

ROYAL INSTITUTION, at 3.—The Milky Way and Magellanic Clouds: Sir F. W. Dyson.

CHILD STUDY SOCIETY, at 6.—Psychological Problems arising out of the War: C. Burt.

FRIDAY, FEBRUARY 25.

ROYAL INSTITUTION, at 5.30.—The Commerce of Thought: Sir A. Quiller Couch.

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THURSDAY, FEBRUARY 24, 1916.

THE OXFORD ARISTOTLE.

(1) *The Works of Aristotle.* Translated into English under the Editorship of W. D. Ross. *Magna Moralia, Ethica Eudemia,* and *De Virtutibus et Vitiis.* Unpaged. (Oxford: At the Clarendon Press, 1915.) Price 5s. net. Also: *De Mundo* and *De Spiritu.* (Oxford: At the Clarendon Press, 1915.) Price 2s. net.

(2) *Illustrations of Positivism.* By J. H. Bridges. New Edition. Pp. xiii + 480. (London: Watts and Co., 1915.) Price 3s. 6*d.* net.

(1) THE thanks of all English-speaking students of philosophy and of the history of science are owing for the steady progress which is being made by the Oxford Press in the translation into English of the whole Aristotelian corpus. With regard to the works under review, the student of ethics who is not also a first-rate Greek scholar, owes a special debt of gratitude to Mr. J. Solomon and to Mr. St. George Stock: to the former for his very accurate version of the "Eudemian Ethics." As Mr. Solomon and Mr. Stock both point out, this work has generally been neglected by Aristotelian scholars. But this neglect is surely unreasonable. The "Eudemian Ethics" is at least a commentary on Aristotle's own "Ethics" by a personal pupil reputed to have been best acquainted with Aristotle's mind, and should therefore be authoritative for the understanding of the master's meaning.

Mr. Stock not only gives us an admirably clear and forcible translation of the "Magna Moralia," but he has also provided indexes and detailed tables of contents for this work and for the "Eudemian Ethics." Further, in a short but vigorously written introduction he discusses the whole question of the relations of all three moral treatises which go under the name of Aristotle one to another. As he says, the problem is not unlike that of the three Synoptic Gospels. "All three used once to be ascribed to the direct authorship of Aristotle with the same simpleheartedness, or the same absence of reflection, with which all three Gospels used to be ascribed to the Holy Ghost." A special form of the general question is the question whether the three books common to the "Nicomachean" and the "Eudemian Ethics" (E.N. v., vi., and vii., E.E., iv., v., and vi.) proceed directly from the writer of the former, assumed to be Aristotle, or from Eudemus, the writer of the latter. This question, Mr. Stock observes, is of no great importance, because in any case the doctrine is Aristotle's. The prejudice in favour of the former work is not peculiar to Oxford, where students are nurtured on the "Nicomachean Ethics," or to English or foreign universities, or to modern times, for Grant pointed out that whereas many Greek and Latin writers have written commentaries on the "Nicomachean," there has been no such commentary on the "Eudemian Ethics."

Mr. Stock dismisses somewhat summarily the contention of Prof. Burnet that the curious mathematics of the fifth book must be due to Aristotle, who was no mathematician, and not to Eudemus, who was one of the first mathematicians in an age in which mathematics made more progress than it ever did subsequently until the seventeenth century. Does not this contention reduce, Mr. Stock asks, to the bare statement that Eudemus wrote on mathematics? And have we any independent evidence that Aristotle was so poor a mathematician? The arguments which Mr. Stock marshals for deciding the authorship of the three disputed books are too detailed to be quoted here. His conclusion, arrived at mainly on linguistic grounds, is that the three books contain Aristotle's own doctrine, but that they were not written by him in the form in which we now have them. Part of them, at any rate, we have only as worked up by Eudemus and adjusted to the latter's own work.

Mr. E. S. Forster gives us an extremely spirited version of the "De Mundo," a work which is certainly unauthentic and probably based on two works of Poseidonius, the Μετεωρολογικὴ στοιχείωσις and the Περὶ κόσμου. Prof. J. Dobson is to be congratulated on the success with which he has grappled with the difficulties of the text of the "De Spiritu."

(2) In the second edition of the late J. H. Bridges's "Illustrations of Positivism," issued by the English Positivist Committee under the editorship of Mr. H. Gordon Jones, a number of papers (many of them were originally delivered as addresses or lectures) are included which were published posthumously in the *Positivist Review.* Mr. Jones has also classified all the papers according to their subject-matter, and supplied numerous bibliographical and explanatory footnotes, as well as an index. To the present-day reader some of these essays may seem to breathe the breath of bygone controversies. Others, on the contrary, as, for example, the brief account of Captain A. T. Mahan's book, "The Influence of Sea-Power upon History," will be read with special interest to-day. Whatever topic he wrote on, Bridges was never dull. He was possessed of an extraordinarily fine sense of historical perspective, and,

accordingly, everything he wrote was informed with a magnanimity which makes these articles something more than mere journalism. Written as they mostly were for the *Positivist Review* by way of commentary on current literary and social events, their sanity and directness of presentation and their simplicity of style have done much in this country to win acceptance for Positivist doctrine. E. H. STRANGE.

MECHANICS AND ENGINEERING TECHNOLOGY.

(1) *Mechanical Technology: being a treatise on the Materials and Preparatory Processes of the Mechanical Industries.* By Prof. G. F. Charnock. Pp. x+635. (London: Constable and Co., Ltd., 1915.) Price 7*s.* 6*d.* net.

(2) *The Theory of Machines.* By R. F. McKay. Pp. viii+440. (London: Edward Arnold, 1915.) Price 15*s.* net.

THERE is a peculiar fitness in bracketing the two above-mentioned books together, inasmuch as they represent almost entirely opposite views of the training of young engineers. By way of illustrating this it may be remarked that the second volume on inspection shows itself the product of an analytic mind, and deals on mathematical lines with the consideration of dynamical and statical forces and their results; thus this volume is one that would only indirectly appeal to the artisan or assistant works manager, and yet is one that should be thoroughly understood by the designer and chief draughtsman. The first volume is, as its heading suggests, a sound descriptive treatise of the most general processes and methods of dealing with raw materials, such as timber, iron, steel, alloys, etc., in order to fashion them into shapes of direct utility. There are in this volume some valuable tables of data obtained from the testing of materials, but there is no mathematics of any kind save a very elementary expression used on pages 6 and 7 in a paragraph on modulus of elasticity. The volume thus has only an indirect interest for the designer but is intensely interesting to the works manager's department, as it is wholly concerned with the properties of the materials used and the methods by which those materials are treated.

(1) This volume on mechanical technology is divided into five parts, the first of which deals with the physical properties of the raw materials: steel, iron, timber, stone, etc., and gives tables of strengths, weights, durabilities, etc. The second portion (150 pages) deals with the manufacture of mild steel, the copper alloys, wrought iron, with a short chapter on the heat treatment of steel. In the chapter on timber the various methods of preserving timber against decay are given, but it is noticeable that "yellow deal" is not given as being used for "street paving blocks." In London most of the streets are now being paved with soft deals, creosoted, and the harder Australian woods, karri and jarrah, are used by the side of the tramway routes. It is good to notice a chapter on oils and lubricants, in view of the immense service of the latter in machine shops and motor transport work. Large buyers of oils should always insist on the regular testing for viscosity and lubricating power, and the variation with rise or fall of temperature. A short chapter on indiarubber concludes this portion of the book. It could be wished that the author had included some details of the manufacture of mechanical rubber goods, such as tyres, etc., seeing that rubber plays such an important part in modern industry. It would be interesting at the moment of writing to know the progress made in Germany in the synthetic production of rubber for mechanical purposes.

Part ii. consists of 170 pages, and is devoted to modern foundry equipment and methods of moulding. This portion of the treatise should be very valuable to engineering students, and it has the merit of many excellent illustrations. Here, again, the reader cannot help regretting that German manufacturers should be able to turn out steel castings which in so many cases are better in quality and finish, together with cheapness, than is the case with us. It is indeed to be hoped that more scientific control of temperatures and mixings will bring back to us preeminence in all classes of foundry work. Part iii. devotes 150 pages to "The Smithy and Modern Forging." The book concludes with some chapters on wire drawing and wire-drawing machinery, and the manufacture of weldless tubes. A list of books of reference which give an extended treatment of the various portions of this treatise, together with a full index at the end, is a pleasing feature. As can be seen from this survey, the book is a very helpful source of information to a student whilst at college, and should be heartily recommended to such a one before he enters the shops.

(2) The education of the mechanical engineer at college is to a very large extent concerned with the teaching of mathematics and its application to engineering design, hence the student spends a relatively large amount of time in the drawing office and lecture rooms, and all too little in the workshop and engineering laboratory. Probably every good teacher would like to give courses of lectures on mechanical technology, but the time at his disposal is all too short, hence this part of the student's knowledge is left for him to pick up

whilst he is actually serving an apprenticeship. The consideration of stress distribution in structures, the effect of dead and live loads, etc., to name only two of many problems in applied mechanics, indicate the type of knowledge which it is the function of colleges to instil, and the outcome of this method of teaching and procedure is the volume under notice.

From the large number of examples appended to each chapter it is to be presumed that the volume deals with the work required by the examinations of the Institution of Civil Engineers and the University of London. Therein lies one defect, viz., that the volume, however excellent its contents may be, is concerned with the attempt to cover a syllabus rather than with the education of a recruit for a live and active industry. The effect of examinations has often been to narrow and cramp the education of a student, and the aim of a college can easily be turned into one of passing a maximum number of students through a given examination rather than fitting such men for an industry which is continually changing in scope and methods. Consider the immense change in almost every branch of engineering work in the last ten years, and the consequence should be that every syllabus of engineering examinations needs revision at least once in a decade. To return, however, to the book under review, the contents are so clearly set out and defined that it is evident the author is a sound teacher. Students of mechanism and the theory of machines cannot do better than work through the various chapters of this book. At the end of so doing they can face with confidence any problems that may arise on such subjects as the profile of wheel teeth, acceleration and accelerating forces, the balancing of engines, cams, trains of wheels, frictional resistances in machines, and the like. Chapter xxx. might with advantage have included a description of the Froude water dynamometer, a machine which will readily absorb any horse-power up to 1000 or more, as the limits of the rope-friction brake are so low.

A. J. M.

METAMORPHIC GEOLOGY.

Metamorphic Geology: A Text-book. By C. K. Leith and W. J. Mead. Pp. xxiii+337. (New York: Henry Holt and Co., 1915.) Price 2.50 dollars.

THIS book is divided into four parts. The first deals with the alteration of rocks by surface agencies (katamorphism), the second with cementation and alteration by deep-seated agencies (anamorphism), the third with the general principles of metamorphism, and the fourth with laboratory work on the subject. The authors concern themselves rather with results than with the chemical and physical processes by which those results are brought about, and they endeavour so far as possible to apply quantitative methods. A special feature of the book is the representation, by graphic methods, of the relative gains and losses of the chemical constituents during metamorphism.

At the conclusion of the first part, after dealing with the weathering of igneous rocks and the nature of the sediments resulting from the erosion, transportation, and redeposition of the weathered material, the authors estimate the amounts of shale, sandstone, and limestone which would be formed by the decomposition and disintegration of an igneous rock of average composition, the assumption being that sedimentary rocks and ocean salts have been derived directly or indirectly from known igneous rocks. We quote the results as illustrating the authors' point of view, and also because of their intrinsic interest. By methods that cannot be here described the conclusion is reached that "100 grams of average igneous rock yield 114 grams of end-products, consisting approximately of 87·8 grams of shale, 12·9 grams of sandstone, 6·7 grams of limestone, and 6·6 grams of ocean salts. Neglecting the ocean salts, these figures correspond to 82 per cent. of shale, 12 per cent. of sandstone, and 6 per cent. of limestone."

A comparison by volume of the average igneous rock with the sediments assumed to be derived from it also leads to interesting results. The volume of the sediment is greater than that of the igneous rock owing (*a*) to addition of material, (*b*) to development of minerals of lower specific gravity, and (*c*) to porosity. That due to (*a*) is estimated at 7·4 per cent., that due to (*b*) at 3·6 per cent., and that due to (*c*) at 17 per cent. on the average, giving an increase of 28 per cent. If the ocean salts be also taken into consideration the total increase becomes 36·9 per cent. The salts of the ocean correspond to 72,000,000 cubic miles of igneous rock and to 92,000,000 cubic miles of sediment. This would represent a thickness of about 0·46 mile over the entire globe, or of 1·39 miles over the continental areas.

The phenomena of "anamorphism" (metamorphism in the sense in which that term is generally used in this country) are dealt with in the second part of the book, and the views of Becke and Grubenmann on the origin of the crystalline schists are discussed. Apart from the diagrams already referred to, only two illustrations are given, and it is difficult to understand why these have been selected from a host of others of at least equal importance.

Some familiar terms are used in a sense that is not likely to find favour on this side the Atlantic. Take, for instance, the following on p. 108: "Extreme induration and recrystallisation of a shale, independent of dynamic action or contact-metamorphism, may produce a highly crystalline rock without cleavage, to which the term slate is usually applied. . . . It is not convenient or necessary to apply any other term than slate to these rocks." A slate without cleavage! Again, on p. 173: "the complete granulation of constituents is sometimes expressed by the term mylonite." The complete granulation of the constituents of a rock gives rise to a *granulite,* not a *mylonite.* Granulites and mylonites may be produced from one and the same rock, but not under the same conditions; hence the necessity of keeping the terms distinct.

The third part of the work treats of such questions as the methods of distinguishing metamorphic rocks of igneous from those of sedimentary origin, and the relation of the saline constituents of ocean, lake, and river waters to the metamorphic processes. The laboratory methods described in the last part relate chiefly to methods of computation and to the construction of graphs, not to methods by which new chemical or physical data are obtained.

OUR BOOKSHELF.

Exercises in Practical Physics. By Prof. A. Schuster and Prof. C. H. Lees. Fourth Edition, revised. Pp. x+379. (Cambridge: At the University Press, 1915.) Price 7*s.* net.

THIS well-known text-book, the first edition of which was reviewed in NATURE of February 20, 1902, now appears in a revised form. A comparison petween the present volume and an earlier edition shows few changes of great importance. Additional paragraphs have been supplied at the ends of some of the sections, but only a small part has been rewritten. A new section on the determination of dip by means of the dip circle is given in an appendix. A more drastic revision would have improved the book greatly, and brought it more into touch with modern methods. The increased use now made in physical laboratories of commercial ammeters and voltmeters would not be realised by a teacher depending only on this volume. We do not find a single exercise in connection with electrostatic measurements. In section lxvi. the Weston cell is now described as the standard cell, and all reference to the Clark cell is omitted; in the following sections, however, the Clark cell is still mentioned as the standard. In the measurement of wave-lengths, Rowland's table is referred to, but no mention is made of the new international scale of wave-lengths. In spite of its somewhat old-fashioned character, the book remains an excellent one both for the teacher and the advanced student.

Bacon's Sixpenny Contour Atlas. Northern Wales Edition. Pp. 41. East Anglia Edition. Pp. 41. South-west England Edition. Pp. 41. (London: G. W. Bacon and Co., Ltd., n/d.) Price 6*d.* net each.

THIRTY-SIX pages of coloured maps and an index to towns is certainly good value for sixpence. Four of the maps—communications, geological, relief, and vegetation—vary with the different editions. Of the others, twenty-five are contoured maps, on various scales, of different parts of the world, and the remaining pages contain nine maps of the world to show different distributions. The somewhat fantastic chart of geographical terms on the last page might well be replaced by another map. We feel also that the two-page introduction to the special maps would scarcely be intelligible to the children for whom this excellent little atlas is designed. The maps are clearly printed, and the colouring on the whole is good. It would be an advantage if the British Isles could be shown in relation to the Continental border of the North Sea, rather than as isolated islands, and if India could be shown on a larger scale. Most of the maps show no railways, but political frontiers are marked by dotted lines. The projection used is indicated on every map, and on a few England is shown on the same scale for purposes of comparison. This should be done on all the extra-European maps. The use of these atlases in lower forms would certainly be of assistance in the teaching of geography. R. N. R. B.

Termodynamik. By P. B. Freuchen. Pp. 143. (København: Lehmann and Stages Forlag, 1915.) No price.

THE scope of this little book is best indicated by the sub-title: "An outline of the history of thermodynamics and the significance of the two chief laws." In the preface the author declares his intention of tracing the development of thermodynamical ideas and their bearing on physics and chemistry. It is not a text-book, but rather a kind of thermodynamical "Who's Who"; successive short chapters deal with Carnot, Clapeyron, William and James Thomson, Robert Mayer, etc. One of these begins: "To read Planck's thermodynamical papers is to breathe pure, clear air."

The various parts of the subject are treated at unequal length; some, which are dealt with in the larger text-books of physics, are entirely omitted. Julius Thomsen's and Horstmann's work is described more fully, but like many other histories, this does not concern itself greatly with the recent past, so that Nernst's theorem occupies only half a page, and the quanta theory is referred to in a single sentence. Although unsuitable for beginners, the book should appeal to physicists, and particularly to chemists desirous of extending their outlook. Its publication in Danish speaks well for the scientific public of small countries, and we hope that by means of a translation it may become accessible to a larger number of readers. G. B.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Scottish "Elephant" Designs.

PROF. G. ELLIOT SMITH has referred in NATURE of January 27 to the "conventionalised drawings of the elephant in . . . Scotland," and has been helped by these designs in his building up of an important theory. But, alas! these Scottish drawings are not of elephants.

I have gone most carefully into every known specimen, whole or fragmentary, of these so-called "elephants," for the purpose of attempting an elucidation and reading of the corpus of Pictish symbolism. They are invariably accompanied by other Pictish symbols. From consideration of their positions in series, their varying dimensions, the angles at which they lie, and other factors, I believe I have been able to arrive at a correct solution of the problem of their meaning. I am sure that they never had anything to do with elephants. But whether my solution is right or not, I merely here desire to point out that a close study of the drawings reveals that the supposed trunk consists of two elongated jaws. The other parts of the anatomy are likewise quite non-elephantine in character.

The fancied resemblance of these very early Christian sculpturings to elephant figures was first promulgated some forty years ago by a writer familiar with Indian mythology, who attempted to connect up Scottish with Indian inscriptions and designs. The attempt, however, was speedily abandoned.

LUDOVIC MACLELLAN MANN.

Royal Societies Club, February 1.

MR. MANN's letter serves as a reminder that the discussion of the significance of the Scotch pictures of the elephant has followed a course remarkably analogous to that which has been waged for a century around the American representations of the elephant.

In both cases all the early scholars, as well as those of our contemporaries who do not claim to have a special ethnological insight, are satisfied to regard them as pictures of elephants; but the ingenuity of modern pundits insists on interpreting these sculptures in some more recondite way. In America the ethnologists are not sure whether the creature depicted was a tapir, a tortoise, or a macaw. In Scotland and Scandinavia the dispute around the elephant is maintained by scholars who are wrangling as to whether it is a walrus, a sun-bear, or a lion-rampant! (For the literature the reader should consult Haddon's "Evolution in Art," p. 194; the Earl of Southesk's "Origin of Pictish Symbolism," 1893; and Hildebrand's "Industrial Arts of Scandinavia," 1882.) Your correspondent tells us he has "been able to arrive at a correct solution of the problem," but with singular modesty he declines to tell us what it is.

In 1856 and 1867 the Spalding Club published two magnificent volumes dealing with "The Sculptured Stones of Scotland," in which the learned editor, Mr. John Stuart, brought his wide knowledge and common sense to bear upon the problems raised by the pictures of the elephant, and, I believe, settled the question for all time. He had no doubt whatever that the animal depicted was the Indian elephant, the knowledge of which "was brought into Europe by the Greeks after the Indian expeditions of Alexander the Great" (vol. ii., pp. xi. and xii.).

"The elephant of the Scotch stones cannot be regarded as a likeness but rather as a conventional representation of the animal, and the unvarying adherence to one form would suggest that the sculptors were unacquainted with the original and were not working from a traditional description . . . but rather were copying a figure with defined form" (p. xii). He adds further that the ornamental scrolls found on the elephant were not found on any other beast. These scrolls were derived from the Indian sea-elephant type of "makara."

Mr. Mann's remark that "the fancied resemblance of these . . . sculpturings to elephant figures was first promulgated some forty years ago by a writer familiar with Indian mythology," presumably refers to Col. Forbes Leslie, who, on the first page of his book on "The Early Races of Scotland," states that Mr. John Stuart's work "has been taken as the basis of the present work."

I presume, therefore, that Mr. Mann is not acquainted with the real evidence upon which my case is established.

There is, of course, a very considerable mass of other literature relating to these elephants, both serious argument and modern speculation; but the only other item that I need refer to now is an episode in one of the Norse fairy tales, as translated by Sir George Dasent, of "an old hag drawing water out of a well with her nose, so long was it."

One might make the same remark about this story as Mr. (now Sir) Edward Tylor made in reference to the American legend of the "great elk," told by Father Charleroix ("History of New France," 1744, vol. v., p. 187): "it is hard to imagine that anything but the actual sight of a live elephant could have given rise to this tradition" ("Early History of Mankind").

G. ELLIOT SMITH.

The University of Manchester, February 3.

The Remarkable Warmth of January, 1916.

A COMPARISON of the Greenwich temperatures for January, 1916, with past records may be of some interest.

Record temperatures for the time of year have occurred with considerable frequency this winter, and the warmth of January was unique in many respects. The maximum and minimum temperature observations taken at the Greenwich Observatory are used for the examination of the exceptional character of the month, and the Greenwich records afford trustworthy means of comparison extending over a long period.

The average temperature for January obtained from the maximum and minimum observations for the last seventy-five years is 38·5°, and the mean for January this year was 45·7°, which is 7·2° higher than the average, and it is 2·0° higher than in any January since 1841, the previous highest mean being 43·7° in 1846, which is followed by 43·5° in 1884. There have only been six previous Januarys in the last seventy-five years with the mean temperature as high as 43°. The mean of January, 1916, was 1·5° warmer than December, and 6·5° warmer than November last, whilst the month was warmer than in five Aprils during the last thirty years.

The mean maximum or highest day temperature for the month was 50·6°, which is 7·5° warmer than the average, and is 2·1° above the previous highest mean maximum, 48·5° in 1890, and there have only been four previous Januarys with the mean maximum temperature as high as 48°.

The mean minimum, or night temperature, was 40·8°, which is 7·0° above the seventy-five years' aver-

age, and is 1·4° higher than the previous highest mean minimum, 39·4° in 1846, whilst there have only been three previous Januarys with the mean minimum as high as 39°. The mean minimum of 40·8° is in agreement with the average minimum at the beginning of May or end of October.

The lowest mean temperature for January during the last seventy-five years is 31·6° in 1879, and 31·8° in 1881, which, with January this year, gives a range of 14° for the possible mean temperature.

In January, 1916, there were three frosty nights at Greenwich, the lowest temperature being 29° on January 23, and in the last seventy-five years January, 1884, had only one frost, and January, 1872, had two frosts, whilst the other Januarys during the long period with as few as three frosty nights were 1851, 1853, 1875, and 1890. In twelve Januarys there have been as many as twenty or more frosts, and in 1879 there were twenty-six frosts. There has been no January with more than seventeen frosty nights since the memorable frost of 1895.

There were twenty days at Greenwich with the temperature 50° or above, and the nearest approach to this in previous Januarys since 1841 is seventeen days as warm as 50° in 1890, whilst there is only one other instance, in 1899, with as many as fifteen days as warm.

The highest temperature recorded at any time in January during the seventy-five years is 57° on January 28, 1843, and this temperature was reached both on January 1 and 17 this year. The two closing days of the month were the only occasions on which the maximum or highest day temperature was below the normal; the lowest maximum temperature was 42° on January 31.

There have only been two Decembers in the last seventy-five years with a higher mean than in January, 1916, the instances being 47·2° in 1852, and 45·8° in 1868, and in December, 1912, the mean was 45·7°, identical with last January. The only February with so high a mean was in 1869, the value being 45·8°.

Previous observations to those of the new series from 1841 made at Greenwich show a mean temperature of 44·6° in January, 1834, which is the highest during the last 100 years, and 1·1° lower than January, 1916. CHAS. HARDING.

65 Holmewood Gardens, Brixton Hill.

Lipoids and Vitamines in Margarine and Butter.

IN the issue of NATURE of June 3, 1915, there is an interesting discussion on the presence of "vitamines" in butter and in margarine. The writer of the article on "Modern Substitutes for Butter" states that butter fat is the only fat or oil in which American investigators have shown the presence of vitamines, and he further states that vitamines are closely associated with lipoids, and that it is doubtful whether vitamines could be formed during lactic fermentation.

"S. H. B.," stating as a fact that vitamines are formed by lactic fermentation, concludes that butter and margarine, by being both churned with skim milk, should be equally rich in the precious substances mentioned.

Now there is no evidence about the quantities of vitamines in butter and in margarine. But recent investigations of my own throw some light on the quantities of lipoids in those substances, and with those lipoids the vitamines are closely allied. To find the lipoid content, I proceed as follows:—The liquid fats, oils, butter, and margarine are shaken with an equal volume of hydrochloric acid (sp. gr. 1·19). After the separation of both liquids, part of the acid is let off and diluted with water. The precipitate of lipoids is collected and washed with water, dried, and weighed. I found in 100 c.c. of liquid:—

Butter gr. 0·400	...	Margarine gr. 0·975	...	Sesame oil gr. 0·100
Planta (Vegetable butter) gr. 0·475	...	Klappa (Vegetable butter) gr. 0·750	...	Bran-butter (Vegetable butter) gr. 1·125
Butter-fat (Filtrated) traces	...	Olive oil (Sublime ooo) traces	...	Arachis oil (Cold pressed) traces
Coconut oil (Raffinated) traces	...	Cod liver oil (Cold pressed) traces		

The first conclusion from these figures is that the seat of the lipoids in butter and butter substitutes is not the fat, but the solution with which it is mixed and emulsified.

Further, it is obvious that of the ±0·075 per cent. of lecithin in milk only a part is enclosed in the butter. The remaining lipoids in the skim milk are responsible for the greater part of the lipoid content in margarine. Egg yolk, if added, may prove another source of lipoids in margarine. The high figure for margarine as compared with those for "vegetable butter" may be due to that source.

There is another store of lipoids in the seeds of plants, which is turned to profit in a recent Dutch patent process. There was a serious obstacle in the fact that lecithin enters into chemical combination (Hoppe Seyler, Juckenack), or absorption (Rob. Cohn), with albumins.[1] In order to set it free the seeds are treated with diluted acids or alkalis. "Bran-butter," *e.g.*, is made by treating bran with diluted lime water. The solution thus obtained consists of water, glutelin, lipoids, and salts. With it a mixture of arachis oil and raffinated coconut oil is thoroughly emulsified. To this emulsion is added skim milk, and the butter separated after ripening. Working on these lines a vegetable butter with 1·125 gr. of lipoids in 100 c.c. could easily be obtained. By changing the proportions a higher content may be reached if desired.

It is obvious that a "vegetable butter" of this kind in its lipoid content, and probably also in its vitamine content, is more than equal to butter. As a fact, it has a most marked advantage as a part of the daily diet.

Anyone interested in the process above mentioned and its possibilities as to making butter-like, and even cheese-like products, is invited to correspond with the writer. J. DE RUITER.

Sneek, Holland.

Science Scholarships.

THE leading article in NATURE of February 17 (p. 671) quotes Dr. Shipley and Mr. Roberts, who say, in reference to the candidates for science scholarships at Cambridge:—"No candidate in natural science who reaches the necessary standard of ability is likely to be rejected. But the supply of candidates of sufficient ability is not so great as it should be."

I have not had the opportunity of reading the original letter, but this quotation contains two points on which I may be permitted to make a few remarks. I feel entitled to ask this privilege as between 1890 and 1904 I took a share in the work of scholarship examination, and I am now able to review my work in the light of a more general experience.

First, as to the type and standard of the questions that are set to the candidates, these appear now to

[1] The absorption of lipoids by albumins could be observed by heating sesame oil with bran to 100° C., by which the oil is proved to have lost half its lipoid content.

be very much the same as those in the earlier period. The school science masters claim that they have adopted new methods of teaching. Secondly, as to the supply of candidates, I feel sure if consideration is taken of all classes of schools in the country it will be found that there is a very large number of boys keenly interested in science.

I will submit two suggestions. First, that closer touch with the local education authorities is necessary. Each local authority has a director or secretary who looks after the progress of the boys in his district. The directors are acquainted with the best boys through their local scholarship schemes, and should be able to point out at once the boys likely to make progress. Selection might in certain cases be made on their recommendation only. I will not go further into this means of connecting the universities and the schools, beyond saying that something of the kind exists in certain districts.

I believe that the present form of scholarship does not recommend itself to the less wealthy, and my second suggestion is that some scholarships might take the form of free places, to include education, board and lodging, and a small money grant. I find that the fear of unforeseen incidentals deters many from the thought of a career at Cambridge. The free place should remove this fear.

My experience leads me to think that a Cambridge career under such conditions would appeal to a very much wider field than at present.

SIDNEY SKINNER.

Science in the Civil Service.

I HAVE read with sustained interest your leading article on science in the public schools and the Civil Service. The preference given to classical subjects in the competitive examinations for higher appointments in the Civil Service is patent. This might be remedied, as you appear to suggest, by a different allocation of marks to the various subjects of the examination. But are there not serious objections to the whole system of competitive examinations as applied to these appointments? I venture to suggest that the system should be ended rather than mended—"off with his head," as the Red Queen would say, with admirable directness.

With your permission, I will briefly recapitulate the arguments for such drastic treatment, which I discussed in detail in a paper read at the Teachers' Guild annual conference in January, 1913. The system tends to impose upon universities and colleges an official or bureaucratic curriculum. In so far as it fails to do this, it divides the attention of the student between his university and an external authority. The result may be illustrated from the subjects selected at the competitive examination by the first successful candidate in 1911, representing a course of study which no university in the world would willingly impose upon its students:—English composition, French, mathematics, physics, logic and psychology, moral and metaphysical philosophy, political economy and economic history, and political science. The allocation of marks to various subjects and the arrangement of candidates in an order of merit on an aggregate of marks in a wide variety of subjects must be arbitrary and unscientific. No credit can be given for original literary or scientific work, and no provision is made for the specialisation of study which, within limits, may be desirable for the future work of the successful candidates. There can be no guarantee that various types of training are fairly represented among the successful candidates. Aptitude for administrative work is in no way specifically tested. The top candidate who, from the point of view of scholarship, may be too good, and the last successful candidate, who may not be good enough, are equally accepted. Restricted age limits are a necessary condition of the system. It does not provide fairly for the promotion of men already in the Service. It is unsuitable for women, to whom the privilege of admission to higher appointments in the Civil Service will, without doubt, be more generally conceded in the near future. Indeed, the physical and mental strain which the system entails must be harmful to men in many cases. The need for expensive special preparation handicaps the poorer student. In practice, the system works unfairly as between the students of the old and the modern universities. This is notorious, but the figures for the five years 1906–10 may be quoted. Out of 473 successful candidates, 247 (more than half) came from Oxford, and 142 from Cambridge; only five came from London, two from Manchester, and one from Leeds.

A system of selection on record by a properly constituted board would meet all these criticisms, and might be applied also to the numerous professional appointments now made departmentally. Owing to the war, such a system is already in operation for a certain proportion of the appointments to the Indian Civil Service. I have not much doubt that if the public, as represented by the universities and the learned societies, were to ask for this reform it would be granted. There would not be much official opposition, for Mr. Leathes, the First Civil Service Commissioner, when asked by the Royal Commission on the Civil Service if, supposing all ideas of the misuse of patronage were excluded, the best way of appointment would not be by selection and nomination, answered in the affirmative, provided that you could trust your nominating authority to be not only absolutely honest, but also always industrious, and to have a highly developed judgment. He thought that then, ideally, selection would undoubtedly be superior, but feared that both history and experience had proved that it was an impossible way. The war has intervened since the pronouncement, and we are now, I hope, more disposed to suppress fears and prejudices in face of facts and arguments.

T. LL. HUMBERSTONE.

21 Gower Street, W.C., February 20.

The Place of Science in Education.

SIR EDWARD SCHÄFER will doubtless carry many with him in advocating a revolution in our educational system in favour of making science the foundation of the education given in our secondary schools. But the difficult question remains as to how that can be done. In the memorandum he refers to, a definite step was proposed towards the desired end. Sir Edward Schäfer considers it a halting step, but he does not suggest any alternative course whereby the public can be led to demand that its educational house should be put in order. As one who had some small share in drawing up the memorandum, may I ask Sir Edward Schäfer what course he would like to see adopted in place of the one already indicated?

D. HILL.

11 Airlie Gardens, Campden Hill, W.

Latin as a Universal Language.

I HAVE read with interest the letter of Sir Lauder Brunton on Latin as a universal language. I sincerely hope the matter will not be allowed to drop. As a contribution, may I say that we have taught Latin here as a spoken language for fourteen years past, just as French and German are taught, and the

result is eminently satisfactory. The reality which is given to the study so quickens the boys' interest that their work is much better done, and about one-fifth of the time usually given to the study is enough to bring them up to the usual standard of the open scholarship examinations. But the chief benefit is the effect on ordinary boys in the earlier stages, who can take pleasure and pride in their work when they feel able to use it. We have "Latin teas," Latin plays, and if you choose to address them in Latin on the playing field they will be pleased to respond.

By this reform it is possible to meet the objections usually brought against Latin by scientific men; for it really does teach the language, and at a very moderate cost of time; in the first four years only three-quarters of an hour a day.

W. H. D. ROUSE.

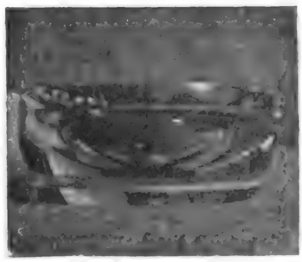
Perse School House, Glebe Road, Cambridge, February 16.

SUBMARINES.[1]

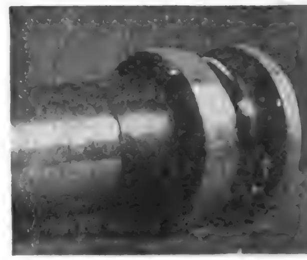
THE author of "Submarines" is to be congratulated on having produced a well-written book upon a subject which has become of the greatest interest to a large world of readers. He tells us that this is not a technical book, and a doubt might arise lest it should in consequence be devoid of any clear or exact information, but this is not the case. The subject is so new and is so little understood that the excellent exposition of the whole subject to be found in the pages will, without doubt, command a large and immediate success. It would be difficult to expend the moderate price of 3*s.* 6*d.* to better account if making a present to any boy with an active mind, and the boy need not be so very young or the mind so very active—it is not written for boys—for the reader to be absorbed in interest.

The book is not technical, *i.e.*, difficulties of shipbuilding design, metacentric heights at different immersions are not considered. The peculiar difficulties in the design of engines are not discussed, though allusion is made to some of the peculiar features of the Diesel engine in particular. Neither the optical problem of the periscope nor its solution is explained in relation to its optical niceties, though, of course, it is discussed generally. These widely differing features are referred to as showing in what way the book is not technical, and for the general interest of the subject as a whole it is well that it is not technical, for there is abundance of interest in the twenty chapters as they stand, and a technical discussion of the numerous items which go to build up the modern submarine would be manifestly impossible. The writer of this notice would only remark in this connection that the account of the periscope would be improved if the optics were a little more fully indicated and if, in particular, the "all round eye" periscope invented by Mr. Funnel and worked out by Mr. Niblett and by Messrs. Aldis had its optical principle more clearly explained. There is an excellent photograph of the all round view taken, not at sea, but in the middle of a street, with a central circular empty patch in which it is proposed to present the direct ahead view on a larger scale (Fig. 1). There is a photograph of the peculiar and special all round lens looking something like a glass insulator for a piano castor, but it is impossible to see how it works, and the photograph of the admirable view obtained by its use makes the insufficiency of the description the more tantalising.

In a subject where there is so much secrecy it is somewhat surprising to find so much information with respect to the German submarines, but this the author obtained directly from the Krupp Company of Essen. He was also provided



The lens unmounted.



The lens mounted in its tube.

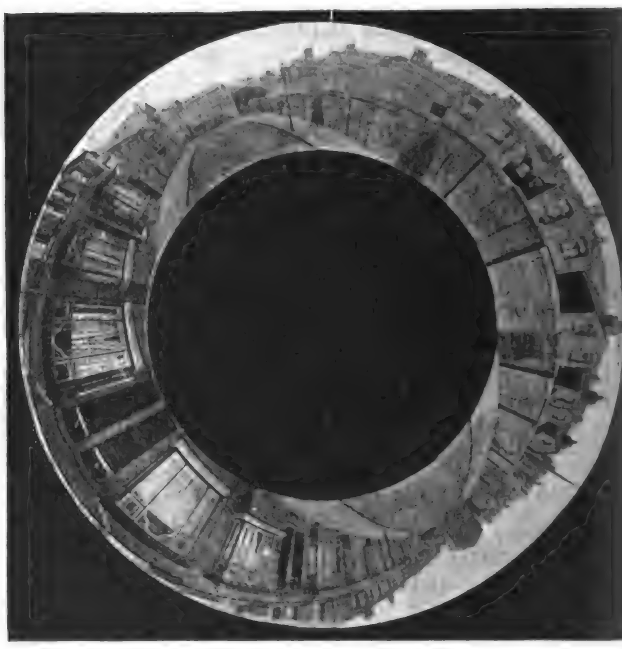


FIG. 1.—The wonderful "all-round view" periscope. The continuous view throughout the 360 degrees of the circle. From "Submarines," by F. A. Talbot. (W. Heinemann.)

with information by submarine builders in America, and from these and other sources he has been able to produce a large number of excellent pictures. It is satisfactory to know that the veil of secrecy surrounding the development of the submarine in this country appears to be unusually impenetrable.

The only misprint, or mis-writing of the nature of a misprint, is on p. 50, where the pressure of the sea-water at a certain depth is given as so many pounds per square foot instead of pounds per square inch.

C. V. BOYS.

[1] "Submarines: their Mechanism and Operations." By F. A. Talbot. Pp. x+274. (London: W. Heinemann, 1915.) Price 3*s.* 6*d.* net.

THE CALIPH'S LAST HERITAGE.[1]

THIS book, of such manifold attractiveness and merit, has an unfortunate sub-title. For, though half the space is given to historical summaries (pp. 1–294), the really valuable part is mainly concerned with the author's travels in Asiatic Turkey in 1906–1913. The History begins with Cyrus the Great, and does not bring us to the Ottoman Turks until chapter xxv., p. 278. It is, therefore, really an historical survey of the lands now comprising the Turkish Empire in Asia for eighteen centuries before the appearance of the Ottomans, and during the first two centuries of Ottoman advance (to the death of Selim the Inflexible). Nearly all this survey is given to the times before the earliest Turkish attack upon our western world—before the advent of the Saljuks and their onslaught upon the Eastern Roman Empire in the eleventh century A.D. Some of the historic maps are well done, and the frontispiece (Restoration of the Round City of Mansur at Baghdad) makes a pleasing and suggestive picture, giving the real features of the Tigris capital of the Abbasids. But few, indeed, of these plans of past time have any reference to the Ottoman Turks.

We hope Sir Mark Sykes's interesting and valuable journeys may at some future time be separately issued in a somewhat shortened form. Certain portions of the diaries might be condensed considerably, but it is fortunate that the author has left the best of his narratives as they were written on the spot, at different dates.

"I have not endeavoured," he says, "to bring them into closer correspondence than they naturally bear to one another, and allowance must be made for modifications in the light of the events in the Ottoman Empire during these years."

These travels cover a very large part of Turkey-in-Asia. Syria, Mesopotamia, Kurdistan, Asia Minor—these are the chief fields; but Turkish Armenia is visited, and we have a short record of a journey in lower Egypt.

"The strategy pursued was to follow my nose over those portions of the map most rich in notes of interrogation and dotted lines."

The personal narratives of Sir Mark Sykes are written from the heart. They are full of vigour and reality, frequently touched with a sarcastic humour, often highly and truly picturesque, and constantly enlightening. They express incidentally the fierce revolt of a modern Western from "the great swindle of representative government, with its excluded merit, and its dingy, incompetent, greedy mediocrities who masquerade as the salt of the earth" (p. 528). For the Christian missions in the Turkish Empire the author has little more affection than for representative government, "the prejudices of Clapham," or "the dogmas Brixtonian" (pp. 389–90). He shudders at "the American College in Beyrut, with its contused and brutish ornaments, its soul-less front," or at "the solid vulgarity of the Robert College, Constantinople—the incubators of all supposed to be fashionable and useful in modern Turkey." Particular reference may be made to the sketches of prosperous and progressive Aleppo and of the "magnificent race of people in the making to the east" (p. 298, etc.); to the account of Kastamuni, "perhaps the most beautiful city in all Northern

Kastamuni Peasant showing Gallic type. From "The Caliphs' Last Heritage."

[1] "The Caliphs' Last Heritage: A Short History of the Turkish Empire." By Lieut.-Col. Sir Mark Sykes. Pp. xii+638. London: Macmillan and Co., Ltd., 1915). Price 20s. net.

Asia Minor" (p. 383, etc.); and to the author's visitation of the Coptic monastery of St. Anthony near the Red Sea—a village of sixty houses, in two streets—with its gentle-eyed, hospitable, intelligent monks, and its gardens, guest-house, stores, stables, mill, swimming-bath, oil-press, and churches.

The reader should also turn to the studies of Arab and Kurdish humanity—the refinement and intelligence of the one, balanced by the simplicity, energy, and dare-devilry of the other; to the descriptions of the tumbled grandeur of the Alps of Kurdistan; and to the appendix on the Kurdish tribes, their distribution, numbers, and special features, past or present—this last an excellent piece of work. Finally, he may welcome the writer's appreciation of the merits of Muhammadan life and faith in Turkey, with its gleams of social religion "most admirable to me," of the reality and strength of Muslim devotion, and of the unconscious brotherhood of Islam (*e.g.*, pp. 383–5, etc.; 390; 523, etc.).

FRENCH VIEWS OF THE SYNTHETIC DYE PROBLEM.

IN a recent issue of the *Revue Scientifique* (January 8) Dr. Wahl, the director of the laboratory of the Poirrier works, who is already well known to English chemists as the author of a very readable text-book on organic dyestuffs, deals with the problem of the manufacture of these dyes in France.

In the historical summary of the causes which led to the decline of the dye industry in England and France, Dr. Wahl emphasises the importance of systematic scientific research as an aid to technical progress. This aid to the industrial chemist is illustrated by the work carried out by Hofmann at the College of Chemistry in London during the first twenty years of the youthful industry. An application to coal tar dyes of the purely scientific research on organic amines led to the discovery of Hofmann's violet and similar colours. The return of this scientific investigator to Germany in 1865 shifted the centre of gravity of the colour industry, for subsequently many of the master's German pupils also left the country and transferred to German factories the practical experience they had originally gained in English works. After a magnificent start the French dye industry came to a standstill, and this halt was prolonged by the disasters of the Franco-German war.

The next important development after 1870 was the production of acid azo-dyes, a discovery which was made simultaneously by French and German workers. In view of the immense range of possible combinations the French firm of Poirrier decided not to patent the new dyes, but in a few months Hofmann published in the *Berichte* the composition of the Poirrier oranges and their method of preparation. The systematic investigation of azo-dyes was a task admirably suited to the German temperament. The preparation and testing of the enormous number of possible combinations required the collaboration of very large staffs of specially trained chemists, whose co-ordinated work on the extensive series of azo-dyes and their generators was a truly gigantic achievement.

This application of the attack by massed battalions to problems of industrial chemistry stood the German colour firms in good stead as other developments arose. For when the French chemist, Vidal, discovered his well-known sulphur black in 1896, the German factories immediately mobilised their armies of chemists and, in the Mackensen drive which ensued, they maintained a steady bombardment of two patents per week, in this class of dyes alone, for a period of eighteen months, with the result that the domain of sulphide dyes was practically annexed by the German colour-makers. This success has been repeated in many other branches of the colour trade, whole sections of which became German monopolies.

First among the scientific causes of this German predominance must be placed the rapid growth in the middle of the nineteenth century of the study of practical organic chemistry, and secondly we have the evolution of large technical laboratories having a scientific organisation of the highest order. Under the leadership of Bernthsen, Bohn, Duisberg, Sandmeyer, and others, continuity of effort, organisation of research, orderly arrangement of references and bibliography produced a sum total of intimate practical knowledge of the subject which could not have been gained in any other less methodical way. This co-ordination of effort in the German colour industry gives rise to 300 patent applications per annum, so that practically each day ushers in a discovery of sufficient importance to justify protection.

Among the commercial factors of this success the most striking is the employment by each German firm of a staff of technically trained representatives who visit the users of their products, demonstrating new methods of dyeing, anticipating the wants and difficulties of their clients, and collecting for their employers a valuable fund of information on the trading side of the business.

So much reliance is being founded in England on the prospects offered by a systematic boycott of German goods after the war that Dr. Wahl's views on this subject are worthy of note. As a professor of the beleaguered University of Nancy he can scarcely be suspected of pro-German bias, and yet he writes as follows:—

In order to sell, one must be prepared to offer the goods at a price equal to or lower than that of the competitors. For I do not think one should attribute to the question of sentiment an importance which it does not possess. If one may suppose that the unpopularity of our enemies will produce, after the war, a period of hesitation in the renewal of commercial relations with them, it would be presumptuous to think that personal interest will not, sooner or later, prevail over other considerations. It will then be essential to be in a position to offer the dyes at prices approximately equal to those quoted by the Germans.

In connection with the British scheme, it has recently been stated that "many hundreds of men, drawn from other occupations, have become chemical workers, and are making more money than they ever earned before." Although it is satisfactory to know that these new-comers in the dye field are already reaping a golden harvest, yet it must be admitted that the existing conditions are exceptional, even in an enterprise largely subsidised by the State. The ultimate justification of this good fortune will be the capacity to meet the foreign rival, whether German or American, with dyes of equal tinctorial value at even prices. As regards the French problem, Dr. Wahl is under no illusions as to an easy victory. He warns his compatriots that in this competition, as in the war, the essential requirements are stupendous efforts, much expenditure of capital, and even more of time.

SIR WILLIAM TURNER, K.C.B., F.R.S.

SIR WILLIAM TURNER, vice-chancellor and principal of the University of Edinburgh, died on Tuesday, February 15, in the eighty-fourth year of his age. His much-lamented death was unexpected. Almost to the day preceding the last illness he had been engaged in university duties, to which his whole life had been devoted. Although for several days previously he had been suffering from a recurrence of slight symptoms of gastric derangement, which for several years had been the one "thorn in the flesh" of an otherwise singularly strong and robust constitution, they had not prevented him from engaging in university work. A profuse gastric hæmorrhage, however, occurred early on Sunday morning, February 13, which produced collapse, soon followed by a painless oblivion, terminating in the final rest of death.

His record is a great one of services to his university and to the cause of education. A distinguished student of St. Bartholomew's Hospital, London, he went to Edinburgh on the invitation of the renowned Prof. Goodsir to assume the office of demonstrator of anatomy. So successful was he in this office and so meritorious were his early contributions to anatomical knowledge that on the death of Goodsir in 1867, he was, by universal approval, appointed to succeed him as professor of anatomy. He brilliantly justified expectation during his thirty-six years of tenure of the chair. Exact and methodical in his teaching, clear and emphatic in his statements to the useful extent of even being somewhat dogmatic, he proved a highly successful expositor of the subject. The anatomy department in his earlier professorial days had a preponderating share in medical education, and the number of students of anatomy was large. Turner's genius for organisation accordingly found ample scope in the arrangement for teaching. He remained professor for thirty-six years, and it is a melancholy recollection that as 1917 would have represented fifty years since he first became professor, former pupils were already considering a jubilee celebration in his honour.

During the tenure of the anatomy chair Sir William Turner had shown, as a member of Senatus, so thorough a knowledge of university affairs, and, above all, so unequalled an ability to deal with financial problems, that he was an easy favourite for the principalship, in succession to Sir William Muir. He was appointed to this high office and also to that of vice-chancellor in 1903. The one reservation that found expression in some quarters was the possibility that he might exhibit a bias in favour of medical interests. He, however, assumed office with the declared intention of acting always in the best interests of all the faculties, and he loyally carried out this intention. A retrospect shows how wholeheartedly he furthered the well-being and success of all the faculties. He has left his impress on the development of each of them, which has been so gratifying in recent years. He was largely instrumental in establishing new professorships and lectureships, and in furthering tutorial instruction in arts and science. With unflagging energy and much tact he pioneered schemes for new buildings and new technical departments. On the site of the famous old infirmary, monuments of his untiring energy have been erected for science and arts, rivalling in some respects the palatial buildings devoted to medical education, erected while he was professor of anatomy.

Turner did not confine his activities to university affairs. In 1886 he was appointed member of the General Medical Council, of which body he remained a member for nearly twenty years. On the resignation of Sir Richard Quain in 1898 he was elected president of the council. This high office gave him full opportunity for displaying the qualities of tact, organising power, and familiarity with details, not less than the skill in reconciling conflicting interests, by which he was so conspicuously distinguished. As the mouthpiece of the council he conveyed to the Privy Council the views of the medical profession and the medical authorities on all questions of public and State importance, and thereby his influence on the well-being of the medical profession and on medical practice in the British Empire became a preponderating one. He successively occupied many other high appointments, such as those of president of the Royal Society of Edinburgh, of the Royal College of Surgeons, of the Royal Physical Society of Edinburgh, of the Anthropological section of the British Association, and of this Association itself on the occasion of its meeting in 1900.

Turner's business capacity led to his services being frequently in request on various committees and institutions affecting the public. Notwithstanding these many occupations, the almost unbounded vitality displayed during the greater part of life allowed him to do good and notable original work. He was one of the editor-founders of the *Journal of Anatomy* and a frequent contributor to its pages. His writings on anthropology and

craniology have a world-wide reputation, and the anatomy of the whale formed a favourite subject of research, in which he established a position as a great authority.

This unceasing activity in many spheres did not fail to bring recognition from numerous learned bodes as well as from the Crown. He was created a Knight in 1886, and in 1901 a K.C.B. His native town of Lancaster manifested the pride felt in his world-wide reputation by placing a commemorative tablet on the house in which he was born. Honorary degrees were almost showered upon him. He was an Honorary LL.D., D.C.L., D.Sc., and M.D. of one or other of almost every university in Great Britain and Ireland, and an honorary member of many academies and learned societies throughout the civilised world. It may be added that he was Honorary Lieutenant-Colonel of the Queen's Royal Volunteer Brigade, in the University Company, of which he was an original member at the beginning of the volunteer movement in the early sixties of last century.

Sheer ability and force of character were the weapons by which Turner carved his way to a distinction probably without parallel among his scientific and academic contemporaries. His strong personality gained for him success in the contests which could not be avoided in many of the interests and schemes he sought to advance. His honesty of purpose and soundness of judgment were always apparent, and much opposition was conciliated by his courtesy.

To many he was a dearly loved friend, whose constancy could always be relied upon. Originating, it may be, in the circumstance that both were Anglo-Scots, but probably even more because of the similar lines of biological research which early engrossed their thoughts, he formed a lifelong and very close friendship with Lister. The death of Lord Lister threw a light upon Turner's character and disposition by evoking outward manifestations of such suffering and pained emotion as even his intimate friends could not have anticipated.

How general was the affection and respect and admiration with which he was regarded was manifested in the ceremony which marked the closing of his career. A remarkably representative gathering assembled for the service in St. John's Church, preceding the interment in the Dean Cemetery, where many of his academic predecessors have their last resting place. It included the Lord Provost and Town Council of Edinburgh; the University Court, Senatus and Students' Union and Representative Council; the vice-chancellors and professors of the three other Scottish universities; representatives of the Universities of Oxford and London, of the Royal Societies of London and Edinburgh, of the Royal Scottish Academy and Geographical Society, of the Royal Infirmary, and of many other public bodies and institutions; while, also, Lord Kitchener, rector of the university, was represented by the Commander-in-Chief-in-Scotland.

NOTES.

IN order to clear up any misunderstanding that may arise in consequence of recent legislation concerning reserved occupations, the Royal Society desires to point out that an unmarried chemist of military age entitled to exemption as an "analytical consulting or research chemist" should, unless he has been attested *before* March 2, lodge a claim for exemption with the local tribunal before that date. Men who have been attested should lodge their claims for exemption with the recruiting officer or local tribunal when called up for enlistment; and if such claims be not admitted, a communication stating all material facts in favour of the disputed claim should be addressed at once to the secretaries of the Royal Society, Burlington House, London.

WE learn with regret that Dr. P. Chappuis, the distinguished authority on gas thermometry, died at Basle on February 15.

MR. F. J. CHESHIRE, of the optical branch of the Ministry of Munitions, has been elected president of the Optical Society, in succession to Dr. W. Ettles.

THE death is anounced, in his sixty-ninth year, of Dr. R. G. Alexander, consulting physician to the Royal Infirmary of Bradford and Halifax. Dr. Alexander was a pioneer in the advocacy of open-air treatment of phthisis and other complaints. He was the author of "Phthisis: its Prevention and Treatment," and of "The Art of Prolonging Life."

WE regret to note from the *Engineer* for February 18 the death, on February 13, of Mr. T. de Courcy Meade, the city surveyor of Manchester. Mr. Meade had held his post in Manchester since 1894; his most important work was concerned with the development of the new drainage scheme. He also rendered useful service in connection with the city's town-planning schemes and the reform of slum areas. He was a member of the Institutions of Civil and Mechanical Engineers, and also of several other engineering societies. An account of his work in Manchester is given in a paper which he read in 1914 before the Institution of Municipal and County Engineers.

LIEUT.-COL. STANLEY BOYD, senior surgeon to Charing Cross Hospital, passed away on February 1, after a short illness. He was educated at University College Hospital, and was appointed assistant-surgeon to Charing Cross Hospital in 1882, and was lecturer in anatomy in the school from 1888 to 1897. He was a sound teacher and a brilliant operator, and was particularly interested in the operative treatment of malignant disease. Stanley Boyd was a keen advocate of the claims of women to be educated for the medical profession, and much of the success of the Women's School was due to him. He held strong views on the university question in London, and was one of those who advocated the concentration of medical teaching in a few centres. At the time of his death he was chairman of the Board of Advanced Medical Studies of the University.

By the death of Lieut.-Col. J. W. Stokes, on February 10, the medical fraternity of Sheffield has suffered a great loss. While engaged in the arduous duties of a general practitioner in a highly populous district, he also acted as demonstrator in anatomy for many years in the University of Sheffield. His services in this direction were entirely voluntary, and were very much appreciated, owing to his regularity, punctuality, and the zeal with which he discharged his duties in the anatomical department. In addition to being a stimulating teacher, he helped materially to furnish the department with permanently mounted specimens, which were specially acceptable at a time when funds for equipment were very small. In his busy life he managed to find time to write on anatomical work, in addition to publishing papers dealing with medicine and surgery. His geniality and quiet humour, coupled with a frank, straightforward disposition, won for him great popularity with his colleagues and students alike.

The Canadian Army Medical Corps has sustained a severe loss through the untimely death of Lieut.-Col. Bridge Yates. Born in Montreal in 1865, he was educated at Charterhouse and Cambridge University, after which he returned to Canada, graduating M.D., C.M., at McGill University. After graduating, he spent several months in Germany studying bacteriology, and on his return was appointed lecturer in bacteriology in McGill University. He early became interested in matters of public health, and in ambulance work. In recognition of his services he was appointed a Knight of Grace of the Order of St. John of Jerusalem, and later president of the Province of Quebec Branch of the Canadian Red Cross Society. He took an active part in the reorganisation of the Canadian Army Medical Corps, in 1907, and on the outbreak of war was appointed acting A.D.M.S. for the Montreal District. Col. Yates joined the McGill or No. 3 Canadian General Hospital in February, 1915, and organised the hospital buildings in France, where he contracted his fatal illness.

Mr. J. B. Jordan, news of whose death at Torquay on December 1, 1915, has just reached us, was for many years compiler and editor of the *Mining Record*, first at the Museum of Practical Geology and afterward at the Home Office. He was, however, better known in the world of science as the inventor of the glycerin barometer, which has almost the range of the water barometer without its disadvantages. The readings of this barometer were for a considerable period published daily in the columns of the *Times*. He also devised a simple form of a photographic sunshine recorder; this was apparently suggested by an eccentric genius, a secretary of the Coal Commission, who used coconut shells for the purpose with approximately correct results. Mr. Jordan was also an expert modeller; one of the finest examples of his work in this direction is the model of the Southampton Docks executed for the London and South-Western Railway. Other works of his are a geological section showing the order, superposition, and approximate maximum thickness of sedimentary strata in the British Isles, a geological map of London on the scale of 6 in. to one mile, based on Stanford's well-known map, and a model of London and its environs printed on tin and stamped in tolerably high relief, this last being a very ingenious, interesting, and useful map.

By the death of Col. C. Stonham, C.M.G., senior surgeon to Westminster Hospital, on February 1, we lose not only a brilliant surgeon, but one who distinguished himself in other ways. He was educated at University College Medical School, where he held the posts of demonstrator of anatomy and curator of the pathological museum, and became assistant-surgeon to the Westminster Hospital in 1887. In early life he was an enthusiastic mountaineer, and as a member of the Alpine Club made some noteworthy climbs. While busily engaged in hospital work and private practice he found time to make observations on bird-life, formed a rare collection of British birds and their eggs, and published his "Birds of the British Islands," notable both for the bird-lore contained in it and for the beauty of the illustrations. Col. Stonham commenced his military service as surgeon in the Middlesex Yeomanry, and in the South African war organised and took out as surgeon-in-chief the Imperial Yeomanry Field Hospital, and for his services in this campaign was made a C.M.G. He afterwards continued his ambulance work and organised a mounted ambulance unit, which was ready for active service on the outbreak of war. He was ordered to Egypt, where he became inspector of hospitals, but his health failed, and he had to return to Europe at the end of last year. A man of striking personality, his untimely death is a great loss to his profession.

From a letter to the *Times* of February 18, by Prof. J. Joly, it appears that experiments which he has carried out in collaboration with Prof. H. H. Dixon show that the undressed swimmer immersed in water at 8° C. loses heat from the surface of his body very nearly three times as fast as the dressed swimmer. The explanation is simple, since the clothing limits the mobility of the water, and it is the constant contact of fresh cold water with the surface of the body which conveys the heat away (by convection, not conduction). The experiments also show that the downward drag of ordinary clothing in sea-water amounts to no more than the weight of 4 oz., and this only after all the air has been expelled from the material. These facts seem to justify the opinion expressed by Prof. Joly, that when there is a probability of prolonged immersion the discarding of clothes is a drawback rather than an assistance, and that the only condition which justifies stripping is the necessity for rapid swimming. Probably the authors would agree that in any case boots should come off.

The general restriction of imports of papermakers' raw materials brings into prominence our growing dependence upon half-manufactured materials, in this case the pulps or "half-stuffs." In adjusting the incidence of the restriction to the various sections of the industry, it is to be noted that the proportion of labour and capital earnings and charges will be relatively less in the case of materials which work up such half-stuffs. On the other hand, the esparto mills are equipped for preparing and boiling the grass, and

for recovering the soda ash used in the boiling, which gives a very different figure for mill costs per ton of output. As to a possible supply of indigenous fibrous material in substitution of the material to be excluded under this order, the only one practically available at the moment is straw. Straw was at one time quite a staple raw material, and was very largely worked at mills favourably situated in agricultural districts. The chemical treatment of straw for producing a bleached half-stuff (cellulose) is closely similar to that of esparto, but it requires a more severe boiling treatment, and the yield of cellulose is much less. Further, from its structural features, it cannot be economically or conveniently handled in the preparing and boiling plant of esparto mills. There is, however, a possibility of adapting this plant to the exigency.

A MEMORIAL has been presented to the Prime Minister and the Chancellor of the Exchequer, signed by many persons of influence, and among them by a considerable number of scientific and professional men and educationists. Its purport is to give emphasis to the demand for national economy, and to urge the necessity of retrenchment in official and municipal expenditure. It recognises that the national finances and the enormous demands made day by day in the prosecution of the war will render necessary heavy additional taxation and much larger savings, both by public bodies and private individuals, than have hitherto been effected. For the latter purpose authoritative guidance from his Majesty's Government is much to be desired. It is suggested, therefore, that a strong official War Savings Board should be constituted, which should lay down regulations for enforcing economy on Government Departments and on public authorities during the period of the war, and should also consider and report on the best means of advising and encouraging domestic thrift. It urges that these measures should be adopted without delay. The memorialists are no doubt addressing persons who will be in full sympathy with their objects. For ourselves we should have been disposed to add to the weighty considerations they have brought forward the importance of that other branch of thrift, which consists in judicious expenditure, and in applying to the best purpose the money which is being lavishly expended directly on the operations of the war, and indirectly on a great variety of objects more or less concerned with the war.

THE danger of relying on popular tradition in questions of archæology is illustrated by a recent case reported by the American Bureau of Ethnology. For many years the people of Georgia have believed that the Nacoochee Mound in White County dated back to the Spanish conquest, and was closely connected with a beautiful local legend. Mr. F. W. Hodge, who has recently excavated the site, finds that the word Nacoochee cannot be traced in the Cherokee language, and that it does not, as has been claimed, mean "Evening Star," a theory on which the legend was based. The mound is really of comparatively recent origin, was constructed by the local Cherokee Indians, and was in use by them until the nineteenth century.

STUDENTS of clan organisation based on the totemistic crest system will be interested in a careful study published as Bulletin No. 19 of the Department of Mines, Canada, which contains an account of the social organisation of the Nass River Indians, by Mr. E. Sapir. This tribe is divided into four exogamous phratries with maternal descent—that is to say, the crests and other privileges descend from a man to his sister's son, and a man's predecessor as the holder of any title or right is not his father, but his maternal uncle. These phratries are again divided into clans, each with a definite order of rank marked by the ownership of special crests, legends, songs, individual names, houses, hunting, and fishing territories, and numerous other inheritable privileges.

AT the monthly general meeting of the Zoological Society of London, held on February 16, it was announced that fifty-seven additions had been made to the society's menagerie during the month of January. The most notable of these were a specimen of Pere David's deer (*Elaphurus davidianus*), now extinct as a wild animal, and an Anoa (*Anoa depressicornis*), presented by the president, and two Argentine frogs (*Leptodactylus mystacinus*) and six South American sand toads (*Bufo arenarum*), new to the collection, presented by Mr. Wilfred Smithers. As compared with the month of January, 1915, there was an increase in the number of visitors of no fewer than 14,407, while the receipts showed an increase of 269*l*.

MISS L. H. HUIE makes an important addition to our knowledge of the parasitic Anthomyiid fly, *Hylemyia grisea*, in the *Scottish Naturalist* for January. Of the life-history of this insect little was previously known. Miss Huie now describes its method of oviposition in the burrows of the wild bee, *Andrena analis*. The larva, on hatching, makes its way to the brood chamber to feed upon the pollen stored for the larval bee, the fate of which in these circumstances has yet to be traced. The author in this communication not only adds materially to our knowledge of this insect, but she also, for the first time, records its presence in Scotland, where hitherto it has not been supposed to occur. In the same number Miss L. J. Rentoul and Miss E. W. Baxter record some useful notes on the moulting of birds in their winter quarters. While adopting the latest eccentricities of nomenclature in regard to the species described, the authors have neglected to acquaint themselves with the morphological terms which have been in use for the last twenty years or so in regard to the plumage.

THE January number of the *Zoologist* contains a valuable summary of the fishing industry at Great Yarmouth, by Mr. A. H. Patterson. The influence of the war is manifest on nearly every page of this report. Among other matters, it is mentioned that in consequence of the diminished fish supply dogfish are now esteemed as food-fishes, large quantities being now eaten locally with relish. The record catch of herring for a single boat was landed on November 1,

This was made by a Scotch boat, and represented some 280,000 herring. The Scotch vessels, indeed, earned enormous sums. While most of the fish taken were consumed at home, some were exported to France, and some to the United States. The Norfolk mussel industry has profited by the suspension of imports from Holland. During the season 87,500 cwt. were taken from the beds of the Boston and Lynn fisheries. The latter were raided by starfish of large size, and "small starfish . . . did much mischief to the brood muscles." This much may be gathered from the fact that as many as two and a half tons of these pests have been taken in one day.

THE improvement of tobacco cultivation in Bihar is one of the subjects which has engaged the attention of Mr. and Mrs. Howard, at the Agricultural Research Institute, Pusa, and their account of the industry with their conclusions is published as Bulletin No. 50, 1915, from the Pusa Institute. Attention at Pusa has been mainly concentrated on the improvement of indigenous varieties of tobacco, and a type has been discovered of light colour and good texture suitable for cigarette tobacco. Green manuring with Sunn hemp has also been found valuable on light, high-lying, well-drained soils. The importance of growing only one kind of tobacco and of growing even fields of the crop is insisted upon, the value of a single variety being evident since cross fertilisation is common in tobacco. The bulletin contains full particulars as to seed sowing, transplanting, manuring, and the principles of curing, for it is largely on the curing that the value of the tobacco depends.

PROF. BAYLEY BALFOUR describes fifty new species of Primula from China, Tibet, and the Himalaya in Notes from the Royal Botanic Garden, Edinburgh, vol. ix., No. xli. The Chinese and Tibetan species are from the collections recently made by Mr. G. Forrest and Mr. F. Kingdon Ward in particular, and Prof. Balfour deals critically with the micro-forms found in several of the Chinese species. A few species described have been collected by Mr. Reginald Farrer, and some also by Mr. Purdom. Among those of more particular interest may be mentioned *Primula alsophila*, Balf. fil. and Farrer, found in the highest woodland zone of the Tibetan forests, with long, creeping stolons running in the moss in which it grows. These stolons are traversed by a fungous mycelium, as is the case with the Pyrolas, among which this species grows, and no doubt through its guest fungus it is capable of absorbing the atmospheric nitrogen. Another striking species is *P. Viola-grandis*, Farrer and Purdom, from Kansu, belonging to the section Omphalogramma, the section bearing irregular flowers. This plant has thick flannel-like leaves and large pale-purple flowers, the three upper lobes lying back over the long tube and the three lower standing out stiffly, like those of a violet. Five other species of this section are known, and Prof. Balfour inclines to the view that this section should be placed in the genus Bryocarpum rather than in Primula.

To assist farmers to rear a larger number of calves and ultimately to increase our food supplies, the West of Scotland Agricultural College has recently carried out a series of calf-feeding experiments at the college farm, Kilmarnock. The report on these experiments by Mr. William G. R. Paterson and Mr. Lindsay Robb is issued as Bulletin No. 68. Four different rations were tested, viz.:—(1) Whole milk; (2) separated milk and crushed oats; (3) separated milk and maize meal; and (4) whey and a special calf meal. The value of these diets, as judged by the average weekly live weight increase of the calves in each group, came out in the order given, but the cost per lb. increase with whole milk was 7·0*d*., against 3·5*d*. for separated milk and either crushed oats or maize meal. The whey ration was not a success. The calves did not like it, and it had a tendency to scour them. The lot fed on whole milk were naturally the best-looking all through the experiment, but the crushed oats group were very little behind. The trials showed that separated milk with either crushed oats or maize meal make suitable and economical rations for calves. It is advisable to feed solely on whole milk for the first four weeks, and to effect the change of ration gradually. These Scotch experiments make an interesting comparison with similar trials carried out by Dr. Voelcker at Woburn in 1912–14. Here the records were continued right up to the slaughter of the animals as two-year-old bullocks, and demonstrated in a striking way the superiority of crushed oats over all the other rations tested.

IN a recent note we remarked on the energy shown in America in the investigation of the problems of protozoa in the soil. Vol. v., No. 11, of the *Journal of Agricultural Research* contains a paper on the relative activity of protozoa in greenhouse and field soils. Mr. G. P. Koch has examined a number of soils in the endeavour to ascertain whether protozoa lead an active life in soils of different moisture content when the temperature is constant and when it is variable. The soil is stirred with a few drops of sterile water and examined under the microscope for two minutes only, thus avoiding errors due to rapid development of encysted forms, as pointed out by Martin and Lewin. According to the author, active protozoa do exist in greenhouse soils, but in very limited numbers, only six out of twenty soils examined showing a few trophic forms. Active protozoa are not found in field soils under normal conditions, but cysts invariably occur which become active in a favourable environment. The moisture content of the soil appears to be the chief factor in determining the presence or absence of active protozoa, while temperature, organic matter, and physical structure are of secondary importance. After heavy rain, when the soil is waterlogged, protozoa excyst and can be found in the active state in standing water. The time required for excystment was found to be longer than that given by previous workers. Small ciliates can excyst in one to two hours at 23° C.; at this temperature flagellates require six to eight hours and large ciliates forty hours. Both moisture and temperature appear to influence the period of excystment. Evidently the two-minute period of examination of each sample is well on the safe side. The author concludes that protozoa are too rarely

active in field soils to operate as a limiting factor in crop production.

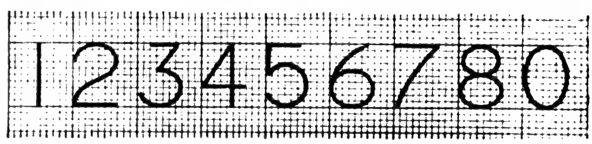
Earthquakes are not frequent in West Africa, but that they are not exceptional is the contention of M. Henry Hubert, who has a paper on the subject in *La Geographie* for November, 1915 (vol. xxx., No. 5). From the information he has collected, which he admits is incomplete, it appears that the region in which earthquakes are most likely to occur is between longitudes 4° and 6° W., which coincides with an area of highly folded metamorphic rocks. The earthquakes are seldom violent, but have been known to reach eight on the scale of De Rossi.

Tides tables for the eastern coasts of Canada and for the Pacific coast for 1916 have been received from the Department of the Naval Service of the Dominion of Canada. It is claimed that, on the basis of length of observation, the tables for the majority of the western ports of Canada are superior to those of any port on the Pacific coasts of America, Asia, or Australia. The tables for Prince Rupert are equal to those for San Francisco, which are based on the longest record of any published for the Pacific coast by the United States Coast Survey. In the case of the eastern ports the lengths of record for the ports of reference—Quebec, Father Point, St. Paul Island, Halifax, and St. John—are longer than those of any Atlantic United States ports. These pamphlets are apparently distributed free of charge to mariners.

The article by "G. H. B." in Nature of January 20 on the proposals regarding "Decimal Coinage and the Metric System" which appeared in the *Electrical Review* has called forth a rejoinder in the issue of that journal for February 4. Our contributor writes with reference to the remarks in the *Electrical Review* :—This correspondence has had at least one good effect, namely, that it has forced the writer of the articles in that journal to state clearly and definitely which system of decimal coinage he proposes to adopt. He would do well to remember that the name "decimal coinage" is vague and meaningless, since every country which has a small monetary unit divided into still smaller cents calls that system a decimal one. In the article in Nature the term was purposely discussed in its most general aspect, and if the writer in the *Electrical Review* considers this to be an indication of "confusion," he and other advocates of currency reform would do well to remember that they have only themselves to blame if endless confusion arises from their failure to adopt a more distinctive name for their system. We are now told that the proposal would not have any effect on international commercial transactions conducted on a large scale (the pound being unaltered), but that it would alter the copper coinage. The change in the latter would be far more confusing to the working classes and the poor than the mere doubling or halving which gave so much trouble in Austria, although it only involved renaming the kreuzer while still retaining the monetary value of that coin. The present reply fully confirms the main contention of our article, namely, that it would be a serious mistake to spoil our prospects of adopting international standards of weights and measures by associating them with a proposal of so fundamentally different a character.

The *Electrical Review* for February 4 contains an illustrated article on the laboratory for heating and ventilation, which has been opened at University College, London, under the charge of Mr. A. H. Barker. The equipment described consists mainly of apparatus for measuring temperatures, radiated and convected heat, the efficiencies of gas and electrical radiators, for testing hot-water pipes, for determining the slope of temperature through the walls to the outside, and for measuring the resistances of air ducts. Mr. Barker's laboratory appears to be the first one established by any university for the special study of the scientific problems of heating and ventilation, but some important pioneer work on the scientific treatment of ventilation was done by Sir Napier Shaw in the Cavendish laboratory at Cambridge twenty years ago. We welcome the inclusion of this work within the sphere of the University, and hope that ere long even those who now advocate the study of Greek verse as an unrivalled educational training will look on the scientific study of the problems underlying everyday life as worthy of some consideration.

Instrument-makers will find some useful suggestions in a short paper by Mr. A. P. Trotter in the Journal of the Institution of Electrical Engineers for February 1. In 1908, Mr. Trotter prepared some



Numerals designed by Mr. A. P. Trotter, minimum thickness.

notes on the most suitable numerals for the scales of measuring instruments; these were recently placed at the disposal of the Meter Panel of the Engineering Standards Committee, and have now been published at their suggestion. Most of the figures which Mr. Trotter proposes as "standard" combine the maximum of legibility and convenience with a considerable degree of elegance; his 2, 3, and 7 are admirable. A more open 5, with the vertical and horizontal lines further to the right, may, however, be preferred; and this would enable the tails of the 6 and 9 (which it is proposed should simply be an inverted 6) to be set at a less violent and unconventional angle without danger of confusion between the 5 and 6; the extension of the horizontal bar of the 5 to the right, beyond the rest of the figure, would preserve its distinction from the 3. A slightly wider 4 would also be an improvement.

One of the principal effects of the war on chemical industry in this country has been to curtail largely the supplies of sulphuric acid available, and to produce an increased output of acid sodium sulphate or "nitre-cake." In many cases it would appear possible to utilise the nitre-cake as a substitute for sulphuric acid. The *Chemical Trade Journal* of January 29 contains an article dealing with the question. A special committee has been appointed in the West

Riding to devise regulations for the substitution of nitre-cake for sulphuric acid in various processes of the woollen trades, and to arrange for the best centres to which the Government Explosives Department can send quantities of nitre-cake for the convenience of local users. The greatest difficulty lies in carting and transport. It is pointed out that the shortage of acid seriously affected the wire trade of some districts, and that the Government, although taking action with regard to the textile trades, has apparently not yet realised how seriously the wire trade is affected by the shortage of acid.

THE final general memorandum on the indigo crop of 1915–16, based upon reports received from provinces containing practically the whole area under indigo in British India, has been issued by the Department of Statistics, India, and forms the subject of a short article in the *Chemical Trade Journal* of January 29. The total area (314,300 acres) is 112 per cent. in excess of the finally revised value of last year (148,400 acres). The total yield of dye is estimated at 39,900 cwt., as against 25,200 cwt., or an increase of 58 per cent. The average output per acre works out at 14 lb., as against 19 lb. in the preceding year. The increase in area is due to high prices of indigo due to the war, which range from 12*s*. to 13*s*. a lb., as compared with 2*s*. 8*d*. in 1913. The season on the whole has not been favourable to the crop, except in Madras. In some places poor crops were obtained owing to a scarcity of trustworthy seed at the sowing time. Data are given showing the quantities of natural and synthetic indigo imported into the United Kingdom in the last five years.

A PAPER on turbo blowers and compressors was read recently before the South Wales Institute of Engineers, and is reprinted in *Engineering* for February 11. The authors, Mr. H. L. Guy and Lieut. P. L. Jones, give very full details and methods of design for both classes of machines. There is also an appendix on the measurement of large quantities of air, and the authors state that the most convenient and accurate method consists in discharging it into the free atmosphere through a standard convergent nozzle. A drawing of this nozzle is given. Care must be taken that the air approaches the nozzle in a steady, uniform stream. It is only necessary to measure the temperature and pressure before and after the nozzle in order to be able to calculate the volume of air passing through it. The coefficient of discharge has been measured for the author's standard nozzle and has been found to be between 1·0 and 0·99.

MESSRS. DULAU AND CO., LTD., will publish almost immediately a translation of Thonner's "The Flowering Plants of Africa: an Analytical Key to the Genera of African Phanerogams." The work, which has been revised and brought up to date, will contain 150 plates.

THE Cambridge University Press has undertaken the publication in this country of two new American medical journals, viz., *The Journal of Cancer Research* and *The Journal of Immunology*. The first-named periodical (which will be issued quarterly) will be the official organ of the American Association for Cancer Research, and contain contributions dealing with statistics, immunology, pathology, and inheritance. The second journal will be a bi-monthly, and represent the American Association of Immunologists and the New York Society of Serology and Hematology.

THE following monographs are in preparation for publication by the Ray Society:—The British Centipedes and Millepedes, by W. M. Webb; The British Earthworms, by the Rev. H. Friend; The British Hydrachnidæ, by C. D. Soar and W. Williamson; The British Ixodoidea, by W. F. Cooper and L. E. Robinson; and The Earwigs of the World, by Dr. M. Burr. The three following works are in course of publication:—The British Desmidiaceæ, by W. and Prof. G. S. West; The British Freshwater Rhizopoda and Heliozoa, by the late J. Cash and G. H. Wailes; and The British Marine Annelids, by Prof. W. C. McIntosh.

OUR ASTRONOMICAL COLUMN.

PERRINE'S COMET (1896 VII.).—This periodic comet is due to return to perihelion about the middle of April. Search ephemerides have been calculated by Dr. G. Stracke from orbital elements obtained from observations made during its 1909 apparition for three assumed dates of perihelion passage, namely, April 7·5, 15·5, and 23·5, and are given in Circular No. 500 of the *Astronomische Nachrichten*. The comet is apparently close to the sun on the opposite side from the earth, and at perihelion will be 200 million miles from the latter.

COMPARISON OF PENDULUMS.—The method of coincidences enables the rates of pendulums to be compared with considerable accuracy even without accessory apparatus. Using the "flash-box"—an optical device that enables the moment of coincidence to be determined with greater precision—estimations of one-thousandth of a second are usually made in gravity work. Seven significant figures are obtained in the deduced times of oscillation of "half-seconds" pendulums. An even higher order of accuracy is claimed for an electro-acoustical method tried by M. A. Perot (*Comptes rendus*, clxii., No. 5), that is stated to render sensible periods less than 1/250,000 of a second. The arrangement employed consists of a battery and condenser shunted through very high resistance, connected in parallel to two open circuits, including telephones. Contacts made by the pendulums under comparison make the circuits, and equality of the sounds given by the two telephones indicates coincidence.

THE VARIATION OF LATITUDE.—Prof. Kiyofusa Sotome, who for a number of years had charge of the latitude observations at Tokyo, suggests an explanation of the Kimura "z," also embracing the lesser-known term given by the chain-method of reduction, namely, the "closing sum." Both together are held to be a measure of the "imperfection" of the spirit-level. In the course of evaluating the micrometer screw by high-latitude stars, it was found that whether the zenith telescope was in the east or west position the bubbles of the pair of attached levels showed a southerly creep about four times greater in winter than in summer. For this two causes are found to be about equally operative; one resides in the spirit-levels and is independent of a regular northward tilt of the telescope that accounts for the other half. The varying inclination of the telescope is due to differential changes in the stand and also to a periodic diurnal

tilting of the pier and ground. Both these effects are of thermal origin, meteorological conditions modified by the observer's presence being responsible for the former, the latter being due to solar heating. Even in the underground chambers where horizontal pendulum work is carried on, daily oscillations of level due to the sun have been manifested. Prof. Sotome next investigates the theory of the motion of the level bubble, the upshot being that the imperfection of the spirit-level is not negligible in zenith telescope observations. It is instructive to note that the errors under investigation are of the order of hundredths of a second of arc! It is finally concluded that both the "*z*" term and the "closing sum" would vanish if the spirit-level were a perfect instrument or if it were replaced by means more nearly ideal, such, for instance, as presented by the Cookson floating zenith telescope (Journ. Coll. of Sci., Tokyo, vol. xxxvii., art. 3).

DINOSAURS.

THE American Museum of Natural History, New York, has just issued Handbook No. 5, giving a popular and well-illustrated account of the Dinosaurs.

Restoration of an Iguanodont Dinosaur, *Thescelosaurus neglectus*, from the Upper Cretaceous of Wyoming, U.S.A., by Dr. C. W. Gilmore. Height 4 ft., length 10 ft.

It has been prepared by Dr. W. D. Matthew, and is in large part a reprint of papers already published by himself, Prof. H. F. Osborn, and Mr. Barnum Brown. Prof. S. W. Williston has also contributed an interesting historical chapter on the first discovery of Dinosaurs in western North America, in which he himself took a prominent part. There is naturally some repetition in the reprints, with occasionally divergent opinions; but the handbook affords an admirable glimpse of the various groups of these strange Mesozoic land-reptiles, besides an ample discussion of the theories as to their modes of life. Several of the beautiful illustrations are only accessible elsewhere in technical memoirs, and Dr. Matthew has added some new synoptical diagrams which will be useful to students.

A small bipedal Dinosaur related to the familiar Iguanodon, and almost identical with the English Wealden Hypsilophodon, has been discovered in the Upper Cretaceous Lance Formation of Wyoming, U.S.A. The greater part of a skeleton, lacking only the skull and neck, has lately been uncovered in a slab of rock in the United States National Museum, and is described by Dr. C. W. Gilmore in No. 2127 of the Proceedings of that museum. The bones lie almost in their natural position, and Dr. Gilmore has wisely decided to leave them undisturbed in the matrix. There are also slight traces of the skin, with fine epidermal tubercles, but no dermal ossifications. The reptile is named *Thescelosaurus neglectus*, and when restored with the head and neck of *Hypsilophodon foxi*, appears as represented in the figure which we copy from Dr. Gilmore's paper. In this attitude it would measure about 4 ft. in height, and it is obviously of very agile proportions, adapted for rapid running.

VENTILATION OF SOILS.

THE relation of soil gases to crop production has received considerable attention during the past year, notably in India. In Bulletin No. 52, issued by the Agricultural Research Institute, Pusa, Mr. and Mrs. Howard discuss the ventilation of soils in the great alluvial plains forming the Ganges basin and in the Quetta valley of north-west India. The authors think that, in a country like India, where water is so often the limiting factor in crop production, too little attention has been paid to the importance of continuous gaseous interchange between the soil and the atmosphere during the growing period. The conclusions reached in this paper are not based on direct experiment, but on long-continued and almost daily observations on the growth of crops. Anticipating criticism on the lack of what they term "test-tube evidence," the authors point out that the greatest advances in British agriculture, both as regards crop production and the improvement of stock, have been made by similar methods.

Having reviewed in detail the agricultural factors of the Bihar district, the phenomena of growth of the more important field crops and trees are briefly described. A large number of examples are given to illustrate the advantage derived by various plants from a free air supply to their root systems. The chief object of the cultivator of these alluvial soils should be to increase porosity and, in the absence of farmyard manure, green manuring or the use of broken brick or tile is recommended. The latter method requires less cultivation.

Similar observations are recorded in the Quetta valley, where both climate and soil differ considerably from those of the Bihar district. Under conditions of artificial irrigation the flooding of the land tends to pack the soil and cut off the supply of oxygen to the plant roots. It is claimed that the principle of more air and less water will not only yield a greater crop, but result in a valuable saving of irrigation water. The paper concludes with a reference to the ecological aspect of soil aeration as shown by the distribution of the gram-growing areas of India. This plant requires a great deal of air, and only a moderate amount of water. Wherever it is successfully grown the soil and system of cultivation are favourable to root aeration. The authors are to be congratulated on their systematic collection of data, which show clearly the importance of controlling the relation between air and water in the soil.

LACE-WING FLIES.

THE latest number of the *Arxivs de l'Institut de Ciencies*, published at Barcelona, contains an excellent monograph of the Chrysopidæ of Europe from the pen of Father R. P. L. Navàs, the well-known authority on the order Neuroptera. The present group, sometimes known as Hemerobiidæ, and in this country as "lace-wing flies," or "golden-eyes," presents many features of interest. From the point of view of economic entomology its importance rests on the fact that in the larval stage it is a great destroyer of aphids. Unlike the almost stationary larvæ of the Syrphids, or hawkflies, which are also of much value as devourers of plant-lice, the Chrysopid larva is able to move actively about from place to place in search of its prey. In this it resembles the larva of the ladybird, another great ally of the agriculturist against the same enemy.

The Chrysopid in its perfect state is a beautiful object; the fresh green colour of its body, which is also prolonged into the delicate tracery of its wings, and the large lateral compound eye-masses, which shine during life like burnished gold, give it an attractive appearance. This, however, is scarcely borne out by its behaviour, for it is capable when crushed or otherwise injured of emitting a most disgusting odour. The latter property may perhaps serve in some degree as a protection to the insect, a suggestion that seems to be favoured by its feeble and fluttering mode of flight. The ova are curious structures, being fastened in groups to the surface of a leaf by means of slender footstalks, thus, as Fr. Navàs points out, resembling a growth of minute fungi.

The present treatise, which is well illustrated, gives a full description of all the European Chrysopids, with a complete bibliography and a key for the diagnosis of the various species.

THE POSITION OF SCIENCE.

MEMORIAL FROM THE IMPERIAL COLLEGE.

THE following memorial, presented by the Right Hon. Arthur H. D. Acland, chairman of the Executive Committee, and Sir Alfred Keogh, rector (now acting as Director-General of the Army Medical Service) of the Imperial College, and by Sir John Wolfe-Barry, chairman of the delegacy of the City and Guilds (Engineering) College, has been forwarded to Lord Crewe, chairman of the governors of the college:—

"To the Marquess of Crewe, K.G., Lord President of the Council, Chairman of the Governors of the Imperial College.

"We, the undersigned, desire to support the Memorandum on the neglect of science in this country which was signed by thirty-six eminent men of science (including four former professors of this College), and published on February 2 last; and as the Imperial College is directed by its charter to concentrate itself on 'Science in its application to Industry and to give the highest specialised instruction and provide the fullest equipment for the most advanced training and research' in various branches of science, we think it right to call your Lordship's attention to the extreme importance of this question at the present crisis in our national history.

"In the Memorandum it is truly said that 'This grave defect in our national organisation is no new thing. . . .' In the year 1887 Prof. Huxley, who was for fifteen years Professor and Dean of the Royal College of Science and Royal School of Mines, which are now with the City and Guilds (Engineering) College integral parts of the Imperial College, said:—'Everybody . . . here is aware that at this present moment there is hardly a branch of trade or of commerce which does not depend, more or less directly, upon some department or other of physical science, which does not involve, for its successful pursuit, reasoning from scientific data.' This statement remains as true now as when it was made.

"We do not wish to take up your time by asking you to see us personally, but we consider it to be our duty to let you know as our Chairman that we cordially support the views of the signatories to the Memorandum, and sincerely hope that in a matter so vital to the welfare of the country remedial measures may be adopted."

The memorial is signed by the following professors, chairs being given in brackets:—H. B. Baker (Chemistry); V. H. Blackman (Plant Physiology); W. A. Bone (Chemical Technology—Fuel and Refractory Materials); H. L. Callendar (Physics); H. C. H. Carpenter (Metallurgy); C. Gilbert Cullis (Economic Mineralogy); W. E. Dalby (Mechanical and Motive Power Engineering); Stephen M. Dixon (Civil Engineering); J. Bretland Farmer (Botany); A. R. Forsyth (Mathematics); A. Fowler (Astrophysics); Wm. Frecheville (Mining); Percy Groom (Technology of Woods and Fibres); E. W. MacBride (Zoology); T. Mather (Electrical Engineering); J. C. Philip (Physical Chemistry); H. G. Plimmer (Comparative Pathology); R. J. Strutt (Physics); Jocelyn Thorpe (Organic Chemistry); A. N. Whitehead (Applied Mathematics); W. Watson (Physics); and W. W. Watts (Geology).

SCIENCE AND GOVERNMENT.

PROF. E. B. POULTON, in delivering the third Galton lecture before the Eugenics Education Society on February 16, said that the justification of the society lies in the fact that man, acting in a community, cannot help letting loose the forces that "improve or impair the racial qualities of future generations either physically or mentally." When these forces are tremendous, as in war, immense future effects must follow. The victory of Germany would impose upon mankind a new criterion, leading to the predominance of a revolting type. But every law, custom, or tradition by which society helps or restrains any of its individual members has some effect for the good or for the evil of future generations. Society is influenced by the tradition that marriage between first cousins is injurious. In consequence of this tradition such marriages are less frequent than they would otherwise be. There is no evidence that the tradition is well founded, and, in July, 1870, Charles Darwin wrote to Sir John Lubbock, pointing out that it was "manifestly desirable that the belief should either be proved false, or should be confirmed," and suggesting that the proper queries should be inserted in the forthcoming census. When the Bill was considered in committee, Lubbock moved to insert the words, "whether married to a first cousin," but the motion was opposed for all sorts of frivolous reasons, and finally rejected by 92 votes to 45. The neglect of eugenics by the Government has been as conspicuous as its neglect of other branches of science. The next general election will reveal a revolution in the political thought of the country, and the urgent necessity for the society will be to fight alongside the other sciences and the great business interests of the country, ensuring that scientific men and business men shall have weight in our future form of Government. When the war came the late Prof. Meldola, with his unrivalled knowledge of the relations between science

and industry, was asked by the authorities to preside over some committees and to serve on others in order to help the Government, and the country, out of the dilemma. He was too patriotic to refuse, but the strain was too great for one who was far from strong, and he died after a few months of overwork. How can the country be saved from the disastrous consequences of the neglect of science? How can the society hope to improve, by means of an enlightened Government, the racial qualities of future generations? The remedy is simple, but there is every reason to believe that it will be effective. All that is necessary is to change the character of the examination for the Civil Service posts and for the Army, giving science a far more important place than it has held hitherto. This change would at once react on our public schools and the old universities, and would bring the members of future Parliaments under the influence of science.

POLARISED LIGHT AND ITS APPLICATIONS TO ENGINEERING.[1]

ONE of the fundamental questions which arises in the majority of engineering problems is the design of a structure or machine which will carry out some predetermined work in an efficient and economical manner, and whatever the problem may be, it is almost invariably bound up with the arrangement of a number of connected parts designed to resist loads which are imposed upon them.

The machines and structures which the engineer has to construct are almost infinite in their variety, and each one usually presents a new and a difficult problem, especially as regards the stresses which may be imposed upon its parts, and the way in which these stresses are distributed.

It is a common experience among engineers to find themselves confronted with a stress problem in their designs which presents almost insoluble difficulties; it often defies mathematical processes, and is beyond the scope of any previous physical investigation. But it must be solved, if only approximately, and the imperative need of an answer renders it advisable to make experimental investigations before proceeding with an important work of construction.

It is perhaps somewhat severe, but not untrue, to say that engineers have not always made the fullest use of the discoveries of pure science in their practice; and it is remarkable that a discovery of Sir David Brewster, in 1816, that transparent materials when stressed become doubly refractive, should not have been more frequently pressed into service, for its use was immediately obvious to the discoverer, who pointed out that the stresses in the arched rings of bridges could be rendered visible in a glass model by aid of the doubly refractive effect produced by a beam of polarised light.

Here and there one finds accounts of applications of this property for engineering work, but usually with little success, mainly owing, no doubt, to the difficulties experienced in shaping glass models to the required form; but when these are overcome the value of the information gained is very great, as, for instance, in the recent valuable investigations of the stresses made upon a glass model of a reinforced concrete arch by M. Mesnager, of Paris, who used the results so obtained for the design of an arch of about 310 ft. span, with a most gratifying agreement between the stresses in the actual bridge and its model. The expense and difficulty of constructing glass models are a bar to their general use, and other transparent materials are now available which offer many advantages, in that they are strongly doubly refracting under stress, are easily fashioned with engineering tools, and are not readily broken or damaged, while the cost is insignificant.

Here, for example, is a rough model of an arch-ring, made of xylonite, and you observe that when loads are applied, it glows with colour in the polariscope, and a picture of the state of internal stress is obtained which can be readily interpreted.

Measurement by Colour Effect.

We can estimate simple stresses by the colours observed.

If, for example, we take a strip of transparent material, and arrange the optical apparatus so that when the strip is unloaded no light is transmitted, the effect of a moderate tension causes the specimen to appear a greyish-white, and, as the stress increases, the colour changes by insensible gradations to a lemon-yellow, then to a reddish-purple, and, with a very little increase of stress, to a well-defined blue. With a further increase of stress, the scale of colours is approximately repeated for twice the intensity of stress, and the relation of colour to stress can be easily determined.

For simple tension and compression, therefore, the stress intensity may be inferred by observing the colour bands, bearing in mind that both tension and compression produce similar effects, if changes in the thickness of the material are allowed for. Thus, if we take the case of a transparent beam subjected to a uniform bending moment, a system of colour bands is obtained, distributed as shown in the accompanying experiment, and, by inspection, the distribution across the section can be determined as shown in the diagram.

This case and others which have been examined afford instances where the results of optical experiments can be compared, not only with mechanical measurements of strain, but also with the theory of the distribution of stress in materials; and the experimental determinations for a transparent material show a very good agreement with strain measurements and with the precise theory. We can, therefore, feel very confident that in more complicated cases the stresses in a transparent model are similar to those in a metal. For example, a beam with a notch cut in it may be taken (as shown), and, as might be expected, the effect of the notch is seen to increase the stress in the material very considerably. The distribution is now much more complicated than it is in a simple beam; the neutral axis has moved towards the notch, while the colour effects show that the maximum stress is at least twice as great as that in a beam without a notch.

Laws of Optical Effect.

In most of the cases arising in engineering work the stress distribution is even more complex, but it is known that any case of stress in the plane of a plate can always be represented by two principal stresses at right angles, and if the magnitude and direction of these are determined for all points the stress distribution is solved.

In order to obtain an experimental solution of this problem, it is necessary to inquire into the relation of the optical effect to the principal stress intensities at a point, and it is easy to show this by simple experiments. If, for example, we take two tension members and subject them to the same uniform stress intensity, the colour effects produced by interference will be precisely the same for each, while if they are superposed the colour effect is that produced on a single member under twice the stress. If, however, two equally stressed tension members of the same thickness are crossed, the common area gives a

[1] Abridged from a discourse delivered at the Royal Institution on Friday, February 18, by Prof. E. G. Coker.

dark field, showing that the stress effect of one neutralises that of the other. The same dark field is produced if an equally stressed compression member is placed with the direction of stress parallel to that of the tension member, and we may readily verify in all cases that tension and compression stresses in the same direction add their effects, while stresses in directions at right angles subtract them.

The latter result is of chief importance, since the stress at any point of a plate can always be represented by the stresses p and q at right angles, and their optical effect is therefore proportional, $p-q$. The value of the stress difference may therefore be determined by matching the optical effect produced at the given point with that produced on a simple tension or compression member. The eye is, however, not a very trustworthy instrument, especially after the fatigue of a few minutes' exposure to a brilliant light; and it is better still to reduce the optical effect to zero by a simple tension or compression member set along one of the directions of principal stress, and stressed until a dark field is produced.

The laws which the optical effects obey may be at once utilised for a variety of cases of practical interest.

obtained, while the dotted curve represents the results of calculation.

In an experiment carried out on a ring in which the inner radius, $r_1 = 0{\cdot}71$ in., and the outer radius, $r_2 = 1{\cdot}43$ in., a pressure of 900 lb. per sq. in. was applied to the interior of the ring, and the experimental values compared with those obtained by calculation. The following results were obtained:—

TABLE I.

Radius r inches	($p-q$) in lb. per sq. inch Experimental value Observed	Corrected for cup leather	Calculated value
0·71 ...	2100 ...	2185 ...	2400
0·85 ...	1560 ...	1625 ...	1660
1·00 ...	1185 ...	1230 ...	1205
1·15 ...	870 ...	905 ...	910
1·30 ...	670 ...	700 ...	715
1·43 ...	— ...	— ...	588

The results show a fair agreement with the theory, which is really closer than the numbers indicate, owing

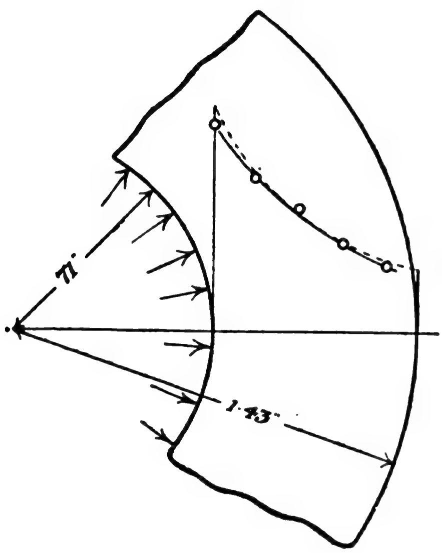


FIG. 1.

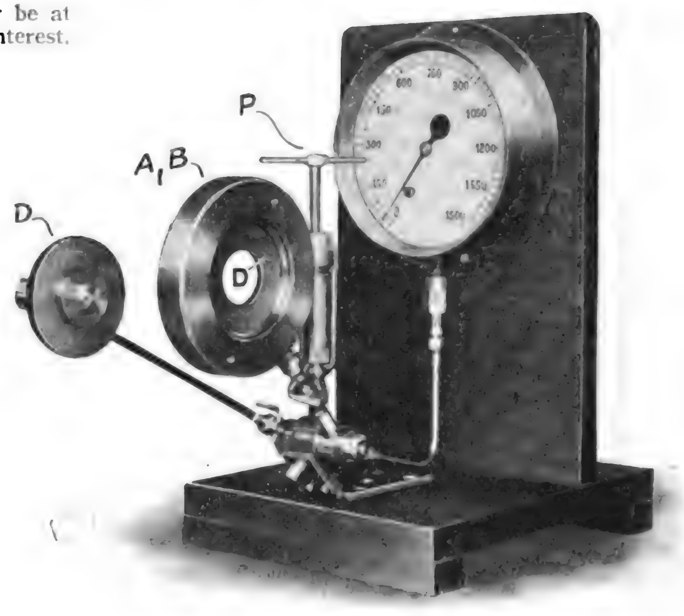


FIG. 2.

Thick Cylinder.

An example is furnished by piping for transmitting fluids under pressure. The action of water, or other fluid, in a pipe, can be imitated by applying a uniformly distributed pressure to the interior of a ring, such as is now shown, where the application of a uniformly applied pressure produces a stress distribution in the circular ring of a perfectly symmetrical character. The arrangement of the colour bands shows that there is a very large stress at the interior surface, diminishing rapidly at first, and afterwards more gradually as the outer surface of the pipe is approached. In this case there is known to be a radial compression stress accompanied by a circumferential tension stress, and the optical effects produced at any point are proportional to the algebraic difference of their intensities —in this case their numerical sum.

In a thick cylinder of these proportions the radial stress is not large, and its intensity can be determined independently, but the combined effects of both stresses have been measured here, and are plotted in Fig. 1, in which the firm line gives the experimental values

to the full pressure recorded on the gauge not being effective, as will now be described.

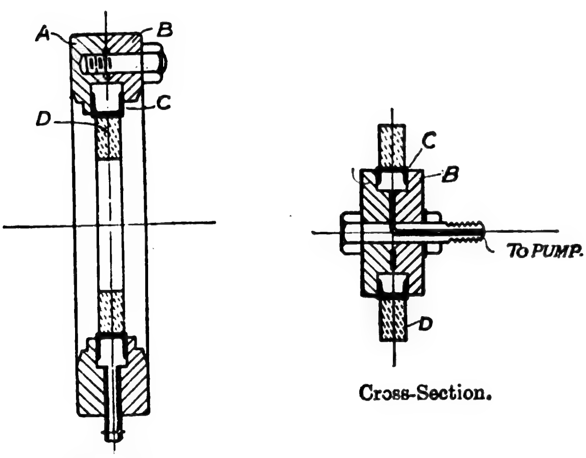
As is evident, this stress problem requires the application of a measurable fluid pressure to the cylindrical surface of a ring, in such a way that no essential part is obscured from view, and a simple and effective means has been devised for this purpose by my assistant, Mr. F. H. Withycombe.

Fig. 2 is a photograph of the complete apparatus for applying internal and external fluid pressure to rings, and drawings of the essential details are shown in cross section in Fig. 3.

Fluid pressure of water or other liquid is applied by the action of a small hand-pump P, the piston of which is actuated by a screw to force oil at any desired gauge-pressure into the annular space between two metal discs A, B, bolted together to hold a retaining ring C, shaped like a Bramah cup-leather to prevent leakage of the fluid. This retaining ring projects slightly beyond the periphery of the discs, and carries the transparent ring to be stressed. The cup-leather is itself so thin that a pressure of a few pounds per

square inch will burst it, but when the ring D is mounted upon it, even a pressure of 2000 lb. per sq. in. may be applied with safety. In the experiments described above, the ring had a thickness equal to the interior breadth of the cup-leather, but a small percentage of the total pressure is absorbed by this leather, and is not exerted upon the ring. The experimental results must therefore be slightly lower than the calculated values, and, if the correction is made, there is a very good agreement, as the table shows. In more complicated cases the stresses are less amenable to calculation, as in cylinders provided with ribs for aeroplane engines, or tubes constructed in sectors bolted together, as in underground railways, but it would not be difficult to determine experimentally the stresses produced under working conditions, although not in so simple a manner.

So far our measurements have only utilised a property which enables us to measure the difference of the principal stresses at a point in a plate subjected to plane stress, but by far the greater number of problems require a knowledge of the magnitudes of each stress separately, as well as their directions, and it is to these determinations which we must now



Cross-Section. Cross-Section.

FIG. 3. Pressure chambers for applying fluid pressure to the internal and external boundaries of rings.

address ourselves. First, as to the determination of the magnitude of the principal stresses:—

Principal Stresses.

A measure of the sum of the principal stresses at a point can be obtained, as Mesnager suggested, if advantage be taken of the fact that the stress causes a change in the thickness of a plate of material proportional to the sum $(p+q)$ of the principal stresses in its own plane. If, for example, both stresses are tensions, there will be a lateral contraction of $(p+q)/m\mathrm{E}$, where E is the modulus of direct elasticity, and m is Poisson's ratio. Both these latter quantities can be determined, and the sum of the stresses can be measured, if an extensometer is used of sufficient accuracy to measure the lateral contraction. For each 1000 lb. of stress intensity, the corresponding lateral contraction for plates of the usual thickness of $\frac{1}{4}$ in. is 1/3000 of an inch, and to measure such a quantity to an accuracy of within 1 or 2 per cent., it is advisable to use an instrument capable of indicating a change of at least one-hundredth of this quantity; such changes have been measured with fair accuracy by using a lateral extensometer capable of detecting a change of about half a millionth of an inch. An instrument of this kind has been employed by Mr. Scoble and myself for an investigation of the stress produced by a rivet in a plate, and a photograph of one form of this apparatus is now shown on the screen.

For investigating cases of plane stress in general the combination of the optical and mechanical methods described here is chosen, in which the sum of the two principal stresses at a point is found by a lateral extensometer, and the difference by an optical measurement, since both can be made to depend upon mechanical measurements only, and are therefore particularly adapted for engineering work. In some cases it requires considerable care to obtain accurate values of each quantity separately, especially if one stress is very much smaller than the other, as then minute errors of observation become a large percentage of the value of the lesser stress; but possibly this difficulty would be met with in any other method.

Lines of Principal Stress.

Reference has already been made to the fact that any state of stress at a point in a plane may be represented by a pair of stresses at right angles through the point.

Between crossed Nicol's prisms a loaded plate shows, in general, dark bands, which mark the positions of all points where the directions of principal stress correspond to the axes of the polariser and analyser, and by varying the angular positions of these latter a series of bands is obtained, each corresponding to definite directions of the axes of stress.

If, for example, the case of a simple tension member is taken, with notches in it on each side as shown, dark bands are observed, and these change their positions as the axes of the optical apparatus are rotated. A diagram may be constructed which shows the centre lines of a number of these curves, with the directions of the axes of stress marked on them. Other lines of principal stress at right angles to the first set are also indicated by the measurements, and the two systems give a kind of framework diagram which shows the direction of the principal stresses at any point, and therefore completes the experimental solution of the problem. The stress distribution in a plate cut to a required form, and stressed in an arbitrary manner by forces in its own plane, is therefore capable of solution experimentally.

Complete Solution.

The complete experimental solution of the stress distribution in a plate stressed by forces in its own plane, may be illustrated by an investigation mentioned above of the action of a rivet near the edge of a riveted joint, since we can determine the sum $(p+q)$ of the principal stresses, their difference $(p-q)$, and their directions. In this problem we can no longer neglect either principal stress, and it is in general necessary to determine both their directions and magnitudes. If the uniform tension stress in the full section of a plate is represented by equally-spaced lines in the direction of stress, we may expect to find alterations in their directions and distances apart as they draw near to the discontinuity produced by the rivet, and an optical examination shows that the lines of stress approach one another very closely as they pass around the rivet, and afterwards diverge again if the overlap of the plate is sufficient to permit this. It is not difficult to explore the whole of a plate stressed in this way, by determining both the sum and difference of the stresses at a sufficient number of points on the lines of stress so found, and some of the measurements for the cross

section passing through the centre of a rivet in a plate are shown in Table II., for the case of a plate in which both the overlap and the widths of metal on each side of the rivet are equal to the diameter of the rivet.

TABLE II.

Stress ratios							
	Stresses across the section						
r/a ...	1·20	1·40	1·60	1·80	2·00	2·50	3·00
$(p_t+p_r)/p$	2·55	2·20	1·84	1·47	1·18	0·70	0·22
$(p_t-p_r)/p$	2·80	1·60	1·00	0·76	0·56	0·10	−0·17
p_t/p ...	2·68	1·90	1·42	1·11	0·87	0·40	0·025
p_r/p ...	−0·125	0·30	0·42	0·35	0·31	0·30	0·195
	Stresses on centre line below rivet						
r/a ...	1·40	1·50	1·70	1·90	2·20	2·50	2·80
$(p_t+p_r)/p$	−4·31	−2·32	−0·90	−0·37	0·44	1·27	2·05
$(p_t-p_r)/p$	−2·56	−2·32	−1·87	−1·48	−1·25	−1·32	−1·60
p_t/p ...	−3·44	−2·32	−1·39	−0·93	−0·41	−0·025	0·225
p_r/p ...	−0·88	—	0·49	0·55	0·84	1·20	1·82

In these determinations the distance r of the point examined is measured from the centre of the rivet

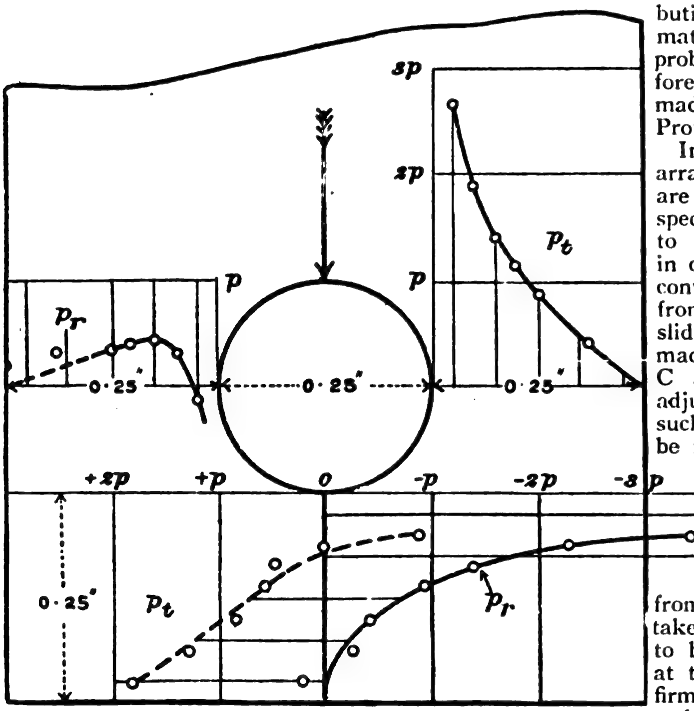


FIG. 4.—Load applied by rivet. Principal stresses.

in terms of its radius a, while the stress p_r across the section and the stress p_t in the section are given in terms of the mean stress.

The experimental values of the principal stresses are given in Fig. 4. They show that the tensile stress at the cross section reaches a high value, while below the rivet an even greater compression stress is produced. The measurements of radial stress along the sections chosen give marked compression close to the rivet, and it is worthy of note that they are very nearly zero at the outer boundaries of the plate, results which confirm the general accuracy of the measurements. Other measurements of a similar kind show that the action of a rivet produces an intense stress at the hole, sometimes reaching five times the stress in a full plate. In a transparent model this is often accompanied by permanent overstress and local yielding, which latter tends to equalise the stress in the material.

Blocks in Compression.

A problem of considerable importance in practical engineering is the distribution of stress in a rectangular block subjected to pure compression. This case occurs in the testing of materials when equal and oppositely directed loads are applied to the parallel faces of a short rectangular block, of a material like stone, brick, or concrete, to give a compressive stress as uniformly applied as is possible.

The manner in which the load is applied to the end faces of such a rectangular block is known to exert an influence upon the distribution of stress and strain, and to obtain consistent results the end faces of small specimens are sometimes faced by aid of a surface plate in order to give a uniform bearing. In a large specimen, where this process becomes very laborious, it is often faced with plaster of Paris, and plates of millboard are sometimes interposed in addition, to give a uniform bearing area between the pressure plates of a testing machine and the specimen.

It is difficult to determine experimentally the distribution of stress in a short block of an engineering material, but if a transparent model is used the problem is comparatively simple; and it may therefore be of interest to indicate what progress has been made in the solution of this practical problem by Prof. Filon and myself.

In the majority of testing machines the mechanical arrangements for applying a pure compression load are defective, and for investigations of this kind a special form of testing-machine was constructed to give a very accurately applied load; and, in order to facilitate the measurements, it was found convenient to suspend the lateral extensometer, X, from a three-point support (Fig. 5), borne by a block sliding upon the vertical pillars P_1, P_2 of the testing machine, and having two cross horizontal slides B and C at right angles, these latter being capable of adjustment by micrometer screws D and E, in such a manner that the measuring instrument could be moved to any position with respect to the specimen B, and the horizontal and vertical coordinates determined to an accuracy of 1/1000 in.

In the photograph now shown a block of square section is subjected to compression stress, and the optical effects show that the stress is far from uniform, although all possible precautions were taken to ensure a perfectly uniform bearing. It appears to be of much less intensity at the end faces than at the centre of the block. The measurements confirm this, and show that there is a very considerable end effect, tending to reduce the compression stress at the centres of the end faces, and only disappearing at a moderate distance away. In work of this kind where it is necessary to examine the effect of the pressure of an opaque body upon a transparent one, there is considerable difficulty in accurately measuring the stresses very close to the boundary between the surfaces.

The diagram now shown of some preliminary measurements indicates the general character of the distribution, in which the curves denote the vertical compression stresses at various distances from the end faces.

The non-uniform character of the stress distribution is evidently due to the way in which the pressure is applied to the material under test, and in this example the brass pressure plates prevent free lateral displacement of the material under load. If, therefore, a more extensible material is interposed for transmitting the load to the block, we may expect to obtain greatest stress at the centre, and this is actually what occurs.

A convenient material to interpose is a thin sheet of india-rubber, and a photograph of the colour effects clearly shows the widely different character of the stress distribution. The stress at the centre line is now the greatest, and it is, moreover, artificially increased 20 per cent. or thereabouts, for the same total load owing to the action of the interposed film of india-rubber, as the measurements

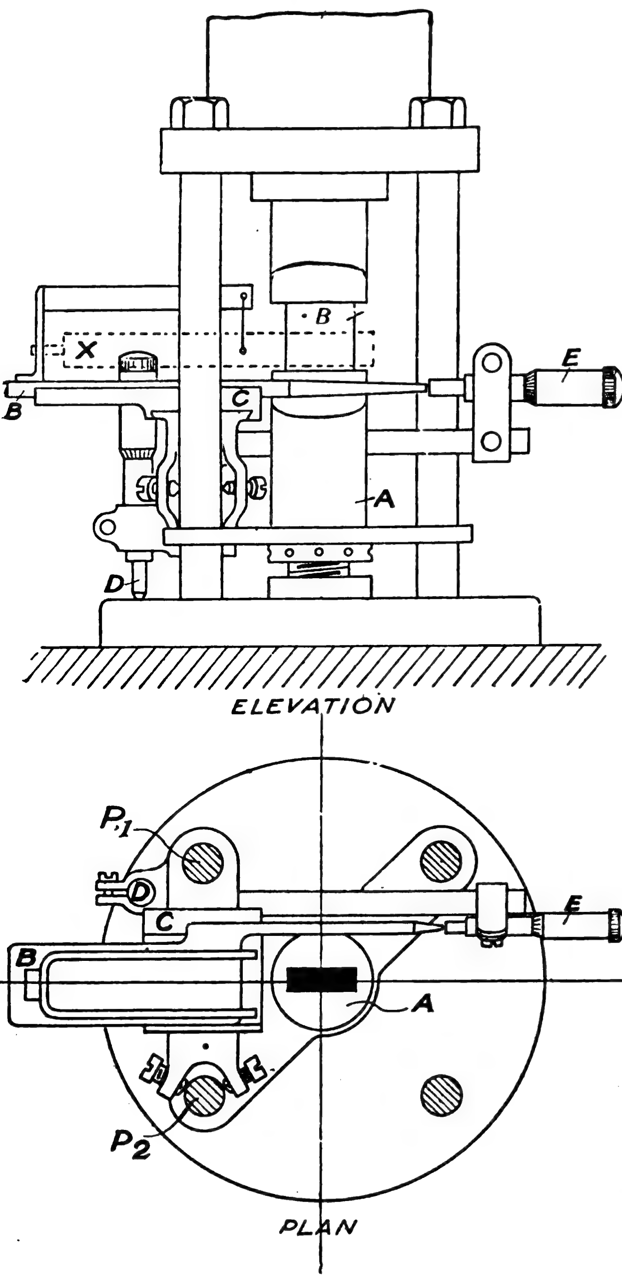


FIG. 5.

show. It is, moreover, not a local effect confined to a small area at the ends, but exerts an effect over the greater part of the block.

The injurious effect of a lead plate, when applied to give a bearing over a block of material under test, is confirmed by this experiment, and the measurements give a quantitative estimate of the increase in stress intensity.

To ensure uniform stress conditions, the experimental results appear to point to the conclusion that the load ought to be applied through an intermediate layer of the same material, and when this is carried out, the block shows a very nearly uniform optical effect, and the measurements prove that the stress intensity is nearly uniform throughout.

Eye-Bars.

A promising development of experimental work with polarised light, relates to the design of machines and structures, especially the detailed parts or components. It has already been pointed out that in the majority of cases the stresses in even the simplest members are so complicated as to defy exact calculation, and with the simplifying assumptions usually adopted, it is necessary to allow for faulty methods by using a large factor of safety.

We may take a very simple example in the case of a member which is merely required to transmit a pull in the direction of its length by means of pins, as shown in the diagram.

If we take a member of rectangular form bored out at each end to receive the pins, then it is at once apparent that the material around the pin is very highly stressed compared with the body of the member, and, as we have already seen in the case of the rivet, there is a compression stress of very large intensity in one region, and a tension stress of considerable magnitude in another, but in the main body of the member, the section is excessive for the load applied. We have here, in fact, the problem which confronted the Deacon in Oliver Wendell Holmes's story of the wonderful "One Hoss Shay," which "ran a hundred years to a day."

> "Fur," said the Deacon, "'t's mighty plain
> Thut the weakes' place mus' stan' the strain;
> 'n' the way t' fix it, uz I maintain,
> Is only jest
> To make that place uz strong uz the rest."

In practice, therefore, the superfluous material of the main body is cut away, and a link is obtained with swelled ends, shaped to resist in the best possible way the stresses which come upon them. The form which these ends shall take to ensure the maximum possible strength is a problem which has exercised the minds of many engineers, particularly those engaged in the construction of large span-bridges of the pin-connected type, where such members occur in considerable numbers and of great size.

Some of the forms of ends which have been very generally used are shown on the diagram, and their diversity indicates the uncertainty which is felt as to the best possible shape; nor is it easy to devise a method of selection unless the stresses in these forms can be measured.

An optical investigation of a model does this effectively and quickly. A very common form is that in which the swelled end has a contour bounded by a circle concentric with the pin, and if we use proportions very widely adopted, it is easy to see from the colour effects on the loaded model now shown, that the stress distribution is unsatisfactory; in fact, at the principal transverse section (Fig. 6) the normal stress is that of compression at the extreme edge, and undue stress is therefore thrown upon the remainder of the section, to balance the total pull on the member. This is also indicated by the lines of stress which have been plotted from the observations.

A much better shape is one devised by Berkeley, and the reason for its special excellence is, I think, clear from the picture of its stressed condition which is before you, from which you will see that the head

is so proportioned that the principal transverse section is wholly in tension (Fig. 7) and is much more evenly distributed than before, while the elongated head allows a more even distribution in the longitudinal section. The contour is apparently not entirely satisfactory, as the head merges into the main body in a somewhat abrupt manner, and suggests that a more satisfactory solution would be obtained by more gradual transition curves following one of the system of curves of principal stress in a member of rectangular form, and of considerable width. If this is carried out as shown in the next model, you will, I think, observe that the effect of this change is a beneficial one, and the lines of stress are less curved, while there are no portions of the head which may be looked upon as of doubtful utility.

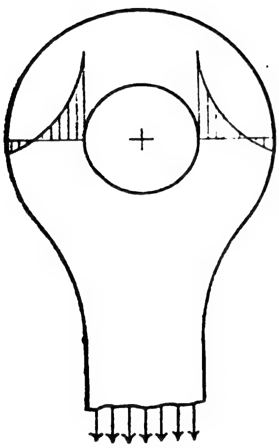


FIG. 6.

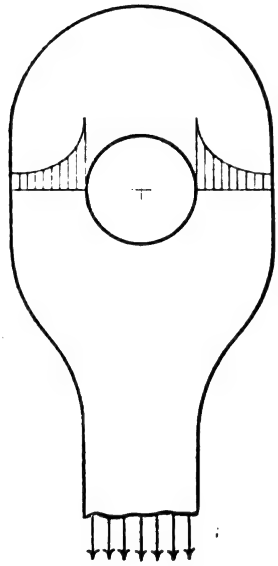


FIG. 7.

Economy in the use and distribution of material to resist stresses in a structure is clearly a most desirable end, and in perhaps no case is this more necessary than in some of the latest developments of modern engineering—the airship and the aeroplane—where weight is a most important factor; and tentative experiments upon models of links used in these structures show that some help in the solution of these new problems may possibly be afforded by optical investigations.

It would not be difficult to supply other examples, but the cases already described are possibly sufficient to show the use of polarised light in engineering problems of stress and strain, and to indicate the possible utility of stress pictures in other fields of applied science and industrial research.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Mr. G. W. Walker, F.R.S., formerly fellow of Trinity College, Cambridge, has been appointed Halley lecturer for 1916, in place of Prince Boris Galitzin, resigned.

The report of the Committee for Rural Economy, which has just been issued, records the fact that the whole of the staff of the school who are of military age have accepted commissions, or are otherwise engaged on work connected with the war. The Sibthorpian professor (Prof. Somerville) has also accepted Government work. In spite of depleted numbers, research has been conducted on representative soils from the Belgian Congo, on soils in the Oxford district, on the reaction of soil constituents towards solutions of phosphate, the comparative value of high and low basic slag, the relation between hygroscopic value and the results of mechanical analysis of soils, the effects of grass, etc., on the growth of trees, the storage of fertility in grassland as the result of the use of phosphates, and the life-history of *Stigmonota coniferana*, a microlepidopteron. The Institute for Research in Agricultural Economics, the aim of which is the application of scientific discovery to the practical business of food-production, has continued its work under considerable difficulty, mainly arising from the war. The chief subject investigated has been the cost of production in agriculture, particularly in regard to the expenditure upon labour. An agricultural survey of Oxfordshire has also been carried out, but many promising inquiries have had to be suspended.

The Board of Finance, presided over by Sir George Murray, has reported that, largely in consequence of the generosity of individuals, of the colleges, and of delegacies, the immediate difficulties of the year 1915 have been surmounted. The Board concurs in the proposal to establish an "Emergency Relief Fund," and thinks that later on in the year it will become necessary to reconsider the financial situation.

Leave of absence on account of war service has been granted to the professor of engineering science (Prof. C. F. Jenkin), and the Waynflete professor of mineralogy (Prof. H. L. Bowman).

MISS SARAH HOLBORN, who died on January 3, has left the sum of 1000*l.* to the London School of Medicine for Women.

THE conversazione of the Battersea Polytechnic will be held on Saturday next, February 26. The laboratories, workshops, and the polytechnic generally will be on view, and the evening affords an opportunity for the public to see the kind of work which is carried on in the training of men and women to fit them for the higher technical posts in industrial life.

ANNOUNCEMENT of a gift of 50,000*l.* for a library for Amherst College was made at the annual banquet of the Amherst Alumni Association of New York. The library is, *Science* states, to be a memorial to a graduate of the class of 1867 from a brother whose name is withheld. A gift of 30,000*l.* from a graduate of Wellesley College toward the fund for a new administration building is also announced by our contemporary. The donor does not wish her name made known at present.

ACCORDING to a correspondent of the *Times*, some education authorities are contemplating the re-introduction of slates to the schoolroom. Such a step would be a retrograde one, for it is generally recognised by hygienists that the slate and slate pencil—cleaned with saliva and sucked by the pupil—possess considerable capacity for the spread of infectious disease among the scholars. The writing on a slate, moreover, does not stand out so clearly as on paper, and the strain to the eyes is therefore greater.

IN the *Times* of February 18 particulars are published of the loss of libraries and museums by Serbia consequent upon the recent invasion by the enemy. In Belgrade King Peter's private library and the Royal collections were ransacked. At Nish, the complete treasures of the National Library, the University Library, and the libraries of the various faculties, which had been removed from Belgrade, were con-

fiscated and sent to Sofia. The library of the Theological College of Prizrend met the same fate. The priceless treasures of the Ethnographical Museum in Belgrade have been disbanded, and are being divided between Austria and Hungary.

THE duty of the nation towards its children was never more serious and imperative than at the present crisis. We are under a grave obligation to raise up an educated generation of men and women to take the place of those who, being in the main the most virile of the nation, will suffer to an unprecedented extent death and disablement in the course of the war. We have found by bitter experience that our past neglect of education has placed us in grave peril, both in respect of scientific military resources and in regard to industrial and commercial enterprise. Yet, despite the indubitable truth of all this, we find that the education committees are being subjected to extraordinary pressure by interested sections of the nation, not only in rural areas, but in industrial centres also, to economise in essential features in the subjects and means of education, and, not content with this, in requiring that the children shall be released from school at an untimely age. In Lancashire it is demanded by textile employers and employed alike that the full-time school age shall be reduced; in a commercial centre like Bradford a like demand is made, and throughout the agricultural areas the cry is that the children shall be placed at the disposal of the farmers. According to a statement made by the President of the Board of Education a few days ago, there are now some 8000 children otherwise legally liable to attend school who have been exempted by various education committees. The Government should in this matter lead the nation and make unmistakably clear that the child-life shall not be exploited, but conserved so that physically and mentally it shall be fitted adequately for the onerous responsibilities which will surely be required of it. The women of the nation have shown how satisfactorily they have responded to the industrial demand, and there is little doubt that they would be found equal under proper economic conditions to the claims of agriculture.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 17.—Sir J. J. Thomson, president, in the chair.—A. R. **Cushny** and S. **Yagi**: The action of cobra venom. The action of cobra venom has generally been supposed to be exerted in part on the central nervous system, in part on the terminations of the motor nerves. It is shown that there are no symptoms of central nervous action in either cold or warm-blooded animals, and that death occurs from paralysis of the motor nerve terminations in striated muscle. In the frog this is accompanied by slowness, and finally arrest of the circulation from a direct action on the heart. In mammals the failure of the respiration is due to the paralysis of the respiratory nerve terminations, but this is often accompanied by the inhalation of saliva, which accelerates asphyxia. The heart is also weakened by quantities of venom greater than the minimum lethal dose. A number of antidotes were examined, without any great success, because no antidote appeared capable of ejecting the venom from its combinations in the tissues.—L. **Doncaster**: Gametogenesis and sex-determination in the gall-fly, *Neuroterus lenticularis*. Part III. In *N. lenticularis* there are two generations in the year, agamic females appearing in early spring, and sexual females and males in early summer. Previous work had shown that any individual agamic female has only male or only female offspring, and the object of the present work was to discover the nature of the difference between these two classes of agamic females. Two possible cytological causes might account for the fact that some sexual females produce only male-producing offspring, while others produce only female-producing. If each fly pairs only once, the difference might depend on the existence of two kinds of males, or it might arise through differences in the maturation-processes of eggs laid by the two classes of sexual female. No cytological differences in the spermatogenesis of different males could be detected. The maturation phenomena of the eggs (about 300) of fifteen separate females have been examined, and while they seem to fall into two rather distinct types, the differences are not sufficiently considerable to correlate them with the sex-phenomena with any confidence.—Philippa C. **Esdaile**: The structure and development of the skull and laryngeal cartilages of perameles, with notes on the cranial nerves. The writer has had the unique advantage of examining in detail a series of six embryo skulls of perameles. The development has been observed and the ossification of the cartilage and membrane bones described and figured. Many questions of interest have been noted, the most important being the affinities and formation of the ala temporalis and its subsequent ossification from cartilage and membrane.—J. C. **Bose** and S. C. **Das**: Physiological investigations with petiole-pulvinus preparation of *Mimosa pudica*. The present investigation is to show how an isolated preparation of petiole-and-pulvinus of Mimosa may be rendered as efficient for researches on irritability as the nerve-and-muscle preparation of a frog. On isolation of the preparation from the plant, the shock of operation is found to paralyse it. Experimental conditions are described for restoration of excitability which can be maintained uniform for more than twenty-four hours, after which a depression sets in. The rate of fall of excitability becomes rapid forty hours after the operation, the sensibility being finally abolished after the fiftieth hour. For the determination of the *rôle* played by different parts of the pulvinus in response and recovery, response-records were taken when selective amputation was made of (1) the upper, and (2) the lower, half of the pulvinus. It is shown that the excitability of the upper half is eighty times less than that of the lower. Chemical agents induce characteristic changes in excitability. The responses exhibit fatigue when the period of rest is diminished. The passage of a constant current is found to remove the fatigue. Response is enhanced under exposure to light, and diminished in darkness. Light is shown to exert a direct stimulating action on the pulvinus, independent of photosynthesis. Injury caused by cut or section of the petiole induces a variation in the conducting power. Two different effects are produced, determined by the tonic condition of the specimen. In normal specimens, injury depresses the conducting power; in sub-tonic specimens it enhances it.

PARIS.

Academy of Sciences, January 31.—M. Camille Jordan in the chair.—The President announced the death of Guido Baccelli, correspondant for the section of medicine and surgery, and of Edouard Heckel, correspondant for the section of rural economy.—A. **Laveran**: Experimental infections of mice by *Leishmania tropica*; a case of infection by the digestive tract. A detailed description of the transmission of the disease to a mouse by a culture administered by the mouth. Three other mice, similarly treated, were not infected.—S. **Brodetsky**: An analogy between linear differential equations and algebraical equations.—A. **Perot**: A method of observing the coincidences of two

periodic phenomena (see p. 715).—F. **Jadin** and A. **Astruc**: Manganese in some alpine springs. The quantities of manganese found vary from 0·001 mgr. per litre (Aix-les-Bains) to 0·46 (Saint Gervais). Ferruginous springs contain more manganese than those in the same region free from iron.—H. **Devaux**: The presence of a coating resisting wetting at the surface of particles of sand and of arable soil. If particles of sand, dry or containing up to 0·5 per cent. of water, are dusted on to the surface of water, the greater part of the grains float. If the moisture in the sand amounts to 1 per cent., all the grains immediately sink. The non-wetting of the surface of the sand grain is probably due to the presence of a thin layer of organic matter, as this phenomenon is not shown by calcined sand. Soils behave similarly, and the capillary effects produced by this coating must have an important influence on plant growth.—Henri **Grosheintz**: An installation permitting the javellisation of the whole of the municipal water supply of the town of Thann. The special arrangement for mixing the solution of calcium hypochlorite with the water consists of a small pump connected with the large water lift pump, so that the two make stroke for stroke. In this manner 50 c.c. of the hypochlorite solution is injected per cubic metre of water. The bacteriological examination of the water proved the efficiency of the treatment.

February 7.—M. Camille Jordan in the chair.—L. **Maquenne**: The estimation of reducing substances in the presence of an excess of saccharose. Studies on the choice of temperature of reduction and time of heating, and on the quantity of sugar to be used in the analysis. Details of the titration method recommended are given.—Georges **Fontené**: An extension of Poncelet's theorem relating to polygons inscribed in, or circumscribed about, conics.—M. **Darboux**: Remarks on the preceding communication.—S. **Stollow**: The integration of linear equations by equations of successive approximation.—J. **Dejust**: The trace of the blades of a hydraulic turbine in which the pressure decreases linearly along trajectories relative to the stream lines.—Albert **Colson**: The irrational character of solubility formulæ and heats of moistening. A reply to a criticism by M. Le Chatelier.—J. L. **Hamonet**: True homologues of glycerol, heptanetriol. The author gives as the definition of a true homologue of glycerol a substance possessing the formula $CH_2(OH)-(CH_2)_n-CH(OH)-(CH_2)_n-CH_2(OH)$, and describes the preparation of heptanetriol, in which $n=1$.—Henry de **Varigny**: The erosion of the French Cretaceous cliffs on the Channel. Several streeets in Bourg d'Ault are perpendicular to the line of the coast and lead to the edge of the cliff. The changes in length of these streets during the period 1825–1912 have been exactly determined, and show an annual loss of rather more than 26 cm. per annum.—Louis **Gentil**: The existence of recent volcanoes in central Morocco.—Le **Marechal** and M. **Morin**: A new apparatus for the radioscopic localisation of projectiles in the wounded. It is claimed for the instrument described and illustrated that its indications are at least equal to those of the best instruments utilising radiographs, and that no calculation or geometric construction is required.—A. **Lécaillon**: Non-impregnated eggs and parthenogenesis of the silkworm (*Bombyx mori*).

WASHINGTON, D.C.

National Academy of Sciences (Proceedings, No. 1, vol. ii.).—G. F. **Becker**: A possible origin for some spiral nebulæ. It is suggested that nebulæ may be developed from nebulous streamers or "bacula." Comparison of the theoretical shape of the nebulæ at certain stages of their development with the whirlpool nebula is not unfavourable to the hypothesis.—E. W. **Hilgard**: A peculiar clay from near the city of Mexico. The analysis shows that the predominant base is magnesia. A peculiarity of the clay is its exceptionally high absorptive power for water.—Harlow **Shapley**: Studies of magnitude in star clusters. I.—The absorption of light in space. The examination of the Hercules cluster indicates the conclusion that the selective extinction of light in space is entirely inappreciable, and that probably the non-selective absorption in space is also negligible.—Harlow **Shapley**: Studies of magnitudes in stars clusters. II.—The sequence of spectral types in stellar evolution. The giant second-type stars are present in large numbers in the globular clusters. The results offer difficulties for the conventional scheme of evolution of spectral types, but the difficulties are not so severe for Russell's hypothesis.—R. A. **Millikan** and W. H. **Souder**: Experimental evidence for the essential identity of the selective and normal photo-electric effects. Photo-electric phenomena are not in general conditioned by the presence of a gas. All distinctions between the normal and selective effects in lithium have disappeared.—L. A. **Bauer**: Concomitant changes in terrestrial magnetism and solar radiation. Changes in the earth's magnetism of appreciable amount are found associated with changes in solar radiation. Decreased solar constant is accompanied by increased magnetic constant. Various minor but important correlations are established.—A. G. **Mayer**: Submarine solution of limestone in relation to the Murray-Agassiz theory of coral atolls. By exposing pieces of shell of the mollusc Cassis to solution in sea-water for a year under various conditions, it is shown that the rate of solution is too slow to be favourable to the theory that the solvent action of sea-water for limestone is a primary factor in deepening and widening the lagoons of coral atolls.—D. H. **Campbell**: The Archegonium and Sporophyte of *Treubia insignis*, Goebel. Treubia is probably on the whole nearer the leafy liverworts than is any other anacrogynous genus.—Aleš **Hrdlička**: Brief notes on recent anthropological explorations under the auspices of the Smithsonian Institution and the U.S. National Museum. The topics treated are: search for Neolithic human remains in south-western Russia; explorations in the Birusa caves and rock shelters on the Yenisei River, Siberia; development of the child among the Negrito, the African negro, the Eskimo, and native Siberians.—A. G. **Mayer**: A theory of nerve-conduction. The theory of nerve-conduction is based upon the phenomena of adsorption. The results lend no support to the theory that the velocity of propagation of nerve impulse is that of a shear in the substance of the nerve.—A. L. **Kroeber**: Zuñi culture sequences. The author gathered a large number of potsherds in and near Zuñi, and is able to make a tentative chronological classification of the objects.—H. S. **Jennings**: The numerical results of diverse systems of breeding. The proportions of the population which are found after *n* generations arising from continued breeding in various ways are tabulated for twenty-four different methods of mating.—Raymond **Pearl**: The effects of feeding pituitary body (anterior lobe) substance and corpus luteum substance to growing chicks. The commencement of the laying period in pullets is neither retarded nor accelerated by feeding pituitary and corpus substance, but the body growth is retarded.—R. **Goldschmidt**: A preliminary report on further experiments in inheritance and determination of sex. The article states a number of new results found by the author in continuing his earlier work on the interbreeding of gipsy moths. Every gradation of intersexualism from a normal female to a normal male, and from a male

three-fourths of the way toward the female has been obtained.—Raymond **Pearl** and S. W. **Patterson**: The degree of inbreeding which exists in American Jersey cattle. American Jersey cattle are about one-half as intensely inbred when eight generations are taken into account as would be the case if continued brother × sister breeding had been followed. In general, register of merit animals are *less* intensely inbred than the ordinary population.—G. A. **Miller**: Upper limit of the degree of transitivity of a substitution group. The degree of transitivity of a substitution group of degree n which does not include the alternating group of this degree is always less than $5/2\sqrt{n}-1$.—F. D. **Adams** and W. J. **Dick**: The extension of the Montana phosphate deposits northward into Canada. An account of the explorations carried out to ascertain whether phosphate-bearing rocks extend northward from Utah, Idaho, and Montana into Canada. In some places such an extension has been found.

BOOKS RECEIVED.

Royal Botanic Gardens, Kew. Bulletin of Miscellaneous Information. Additional Series ix. The Useful Plants of Nigeria. Part iii. Pp. 343–536. (London: H.M.S.O.; Wyman and Sons, Ltd.) 3*s.* 6*d.*

The Investigation of Rivers. By Dr. A. Strahan, N. F. MacKenzie, Dr. H. R. Mill, and Dr. J. S. Owens. Final Report. Pp. 93. (London: Royal Geographical Society.) 3*s.* 6*d.* net.

The Universe and the Atom. By M. Erwin. Pp. 314. (London: Constable and Co., Ltd.) 8*s.* 6*d.* net.

Madras Government Museum. The Foote Collection of Indian Prehistoric and Protohistoric Antiquities. Catalogue Raisonné. By R. B. Foote. Pp. vii+262. (Madras: Government Press.) 3*s.*

Madras Government Museum. Catalogue of the Prehistoric Antiquities from Adichanaltur and Perumbâir. By A. Rea. Pp. xiii+49+plates xiii. (Madras: Government Press.) 2*s.* 3*d.*

Hopwood's Living Pictures. By R. B. Foster. New edition. Pp. x+377. (London: The Hatton Press, Ltd.) 6*s.* net.

Memoirs of the Geological Survey. Special Reports on the Mineral Resources of Great Britain. Vol. i., Tungsten and Manganese Ores. By H. Dewey and C. E. N. Bromehead. Pp. iv+59. Vol. ii., Barytes and Witherite. By R. G. Carruthers and others. Pp. iv+93. Vol. iii., Gypsum and Anhydrite, and Celestine and Strontianite. By Dr. R. L. Sherlock and B. Smith. Pp. 57. (London: H.M.S.O.; E. Stanford, Ltd.) 1*s.*, 1*s.* 6*d.*, and 1*s.* respectively.

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 24.

ROYAL SOCIETY, at 4.30.—Mathematical Contributions to the Theory of Evolution XIX. Second Supplement to a Memoir on Skew Variation: Prof. Karl Pearson.—The Relative Combining Volumes of Hydrogen and Oxygen: F. P. Burt and E. C. Edgar.—Speed Effect and Recovery in Slow-speed Alternating Stress Tests: W. Mason.—The Ignition of Gases by Impulsive Electrical Discharge: W. M. Thornton.

ROYAL INSTITUTION, at 3.—The Milky Way and Magellanic Clouds: Sir F. W. Dyson.

CHILD STUDY SOCIETY, at 6.—Psychological Problems arising out of the War C. Burt.

INSTITUTION OF MINING AND METALLURGY, at 5.30.—The Conglomerates of the Witwatersrand: E. T. Mellor.—A Pioneer Bucket Dredge in Northern Nigeria: H. E. Nicholls.—Antimony Production in Hunan Province, South China: A S. Wheler.

FRIDAY, FEBRUARY 25.

ROYAL INSTITUTION, at 5.30.—The Commerce of Thought: Sir A. Quiller Couch.

SATURDAY, FEBRUARY 26.

ESSEX FIELD CLUB (at the Essex Museum, Stratford), at 3.—Grasses: J. Groves.

TUESDAY, FEBRUARY 29.

ROYAL INSTITUTION, at 3.—The Plant and the Soil—Nature's Cycle: Dr. E. J. Russell.

WEDNESDAY, MARCH 1.

ENTOMOLOGICAL SOCIETY, at 8.—Specific and Mimetic Relationships in the Genus Heliconius, L.: Dr. Harry Eltringham.

SOCIETY OF PUBLIC ANALYSTS, at 8.—The Manufacture of English Chemical Filter Paper: E. J. Bevan and W. Bacon.—Pink Colour on the Surface of Margarine: A. W. Knapp.—A Rapid Method for the Estimation of Fat in Powders: S. B. Phillips.—A New Colour Reaction for Aloes: C. E. Stacy.

INSTITUTION OF ELECTRICAL ENGINEERS (Students' Section), at 7.45.—Suggested Applications of Science to Warfare: R. E. Dickinson.

THURSDAY, MARCH 2.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* The Antiseptic Action of Substances of the Chloramine Group: J. B. Cohen, H. D. Dakin, M. Daufresne and J. Kenyon. The Structure of the Dicynodont Skull: I. J. B Sollas and Prof. W. J. Sollas.—Analyses of Agricultural Yield. Part III. The Influence of Natural Environmental Factors upon the yield of Egyptian Cotton W. L. Balls.—The Function of Chlorophyll, Carotin and Xanthophyll: A. J Ewart.

ROYAL INSTITUTION, at 3.—Recent Excavations in Mesopotomia—The Northern Capitals, Nineveh and Asshur: Prof. L. W. King.

CHILD STUDY SOCIETY, at 6.—The Danish Child at School: A. E. Hayes.

LINNEAN SOCIETY, at 5.—Exhibit of *Giardia* (*Lamblia*) *intestinalis* from cases of Diarrhœa in Soldiers, the Infections being contracted in Flanders: Dr Annie Porter.—Larval and Post-Larval Stages of *Jasus lalandii*: Dr. J. D. F. Gilchrist.—The August Heleoplankton of some North Worcestershire Pools: B. Millard Griffiths.—The Distribution of the Box-tree, *Buxus sempervirens*: Dr. Otto Stapf.

FRIDAY, MARCH 3.

ROYAL INSTITUTION, at 5.30. Corona and other Forms of Electric Discharge: Prof. S. P. Thompson.

GEOLOGISTS' ASSOCIATION, at 7.30.—The Oil-fields of Trinidad: V. C. Illing.

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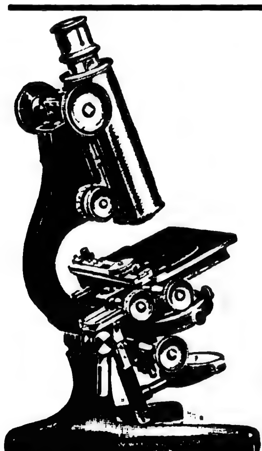

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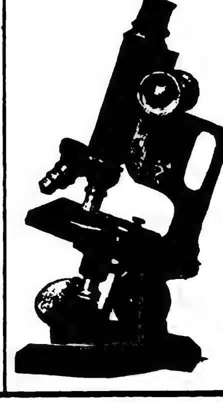

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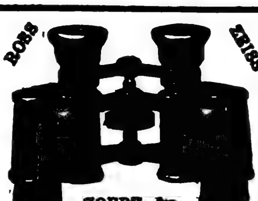

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One Eighth Page, or Quarter Col....	0	18	6	Whole Page	6	6	0

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NATURE

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"To the solid ground
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No. 2394, Vol. 96] THURSDAY, SEPTEMBER 16, 1915 [Price Sixpence

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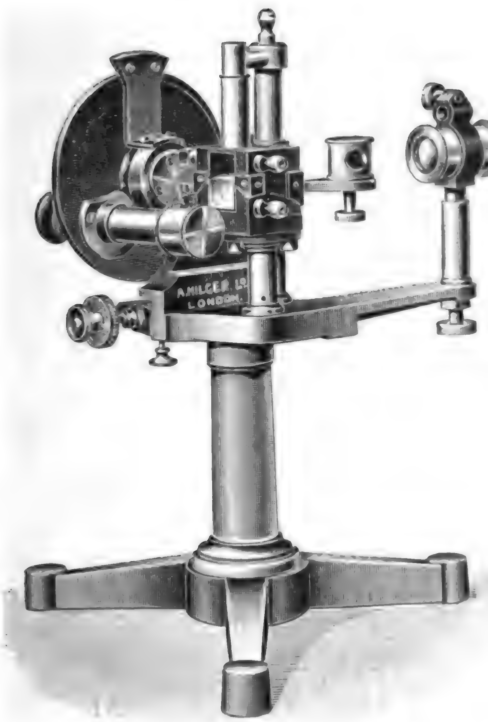
For other Official Advertisements see pages xx, *and* ii *of Supplement.*



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No. 2395, VOL. 96] THURSDAY, SEPTEMBER 23, 1915 [PRICE SIXPENCE

Registered as a Newspaper at the General Post Office.]

HERIOT-WATT COLLEGE, EDINBURGH.

PRINCIPAL . . A. P. LAURIE, M.A., D.Sc.
(sometime Fellow of King's College, Cambridge).

THEORETICAL AND PRACTICAL TRAINING FOR MECHANICAL ENGINEERS, MINING ENGINEERS, TECHNICAL CHEMISTS, BREWERS AND DISTILLERS.

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For full particulars apply to the PRINCIPAL at the College.

For the NEW SCHEME for ENGINEERING DEGREES in CIVIL, MECHANICAL, and ELECTRICAL ENGINEERING, arranged with the UNIVERSITY of EDINBURGH, see the Calendar of the University and the Calendar of the Heriot-Watt College.

PETER MACNAUGHTON, S.S.C.,
Clerk.

Heriot-Watt Offices, Edinburgh,
August 10, 1915.

THE MANCHESTER MUNICIPAL

SCHOOL OF TECHNOLOGY.

(UNIVERSITY OF MANCHESTER.)

PRINCIPAL: J. C. M. GARNETT, M.A. (late Fellow of Trinity College, Cambridge).

The Session 1915–16 will open on October 5.

The Prospectus, forwarded free on application, gives particulars of the courses leading to the Manchester University degrees in the Faculty of Technology, in the following Departments:—

MECHANICAL ENGINEERING,

ELECTRICAL ENGINEERING,

SANITARY ENGINEERING (including Municipal Engineering),

THE CHEMICAL INDUSTRIES (including General Chemical Technology, Bleaching, Dyeing, Printing, Papermaking, Brewing, and Metallurgy),

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(Mathematics and Elementary Science.)

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(Mathematics, Chemistry, Physics.)

Norwood Technical Institute, Knight's Hill, West Norwood, S.E.
(Mathematics, Chemistry, Physics, Botany.)

Paddington Technical Institute, Saltram Crescent, W.
(Mathematics, Physics, Chemistry, Botany, Zoology.)

Classes are also held on Saturday mornings.

Full Prospectus may be obtained on application to the Secretaries of the respective Institutions.

JAMES BIRD,
Clerk of the London County Council.

London County Council,
Education Offices,
Victoria Embankment, W.C.

EDINBURGH & EAST OF SCOTLAND COLLEGE OF AGRICULTURE.

SESSION 1915–16.

The WINTER SESSION begins on OCTOBER 12.

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ALEXANDER M'CALLUM, M.A., LL.B.,
Director and Secretary.

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COURSES are held and DEGREES are awarded in the following Faculties:—ARTS (including Architecture), PURE SCIENCE, MEDICINE, LAW, APPLIED SCIENCE (including Engineering, Metallurgy, and Mining).

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W. M. GIBBONS, Registrar.

SCHOOL BOARD OF GLASGOW.

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WANTED by the School Board of Glasgow, an ORGANISER for TECHNICAL, SCIENCE and TRADES CLASSES. Must have educational experience and practical experience in engineering or other mechanical trade. Initial salary according to qualifications and experience, but not to exceed £300 per annum. Applications (which must be made on the prescribed form), with copies of testimonials, should be sent to the CLERK TO THE BOARD, School Board Offices, 129 Bath Street, Glasgow, not later than Monday, October 4. All canvassing, direct or indirect, in person or by letter, is strictly prohibited.

For other Official Advertisements see pages xxviii *and* ii *of Supplement.*

BROWNING'S TABLE SPECTROSCOPES AND SPECTROMETERS

These instruments are of the best workmanship throughout; the prisms are of a very dense glass of superior quality, and the object glasses achromatic. The slit is provided with a right angled reflecting prism, by which two spectra may be seen in the field of view at the same time, and may be easily compared. The lines or bands in any spectrum can be accurately measured in degrees and minutes of angular deviation, and refractive indices can be taken, the arc being divided to 360° and reading by vernier to single minutes.

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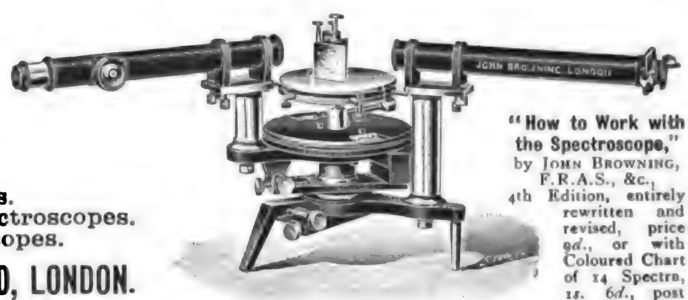

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JOHN BROWNING, MANUF'G OPTICIAN, 146 STRAND, LONDON.

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NATURE.

The number for **last week (Sept. 16)** contained:—

Agricultural Teaching in American Schools. By Dr. E. J. Russell.
Molluscs, Mammals, and Memorabilia. By Rev. Thomas R. R. Stebbing, F.R.S.
An Italian Text-Book of Physiology.
Elementary Geography.
Our Bookshelf.
Letters to the Editor:—
Remarkable Nest of "Vespa Norwegica," and Fertility of Workers of this Species. Oswald H. Latter.—An Original Representation of the Giraffe. (*Illustrated.*) Dr. G. W. Grabham.
The World's Supply of Potash. By W. A. D.
Prof. D. T. Gwynne-Vaughan. By F. O. B.
The British Association at Manchester:—
Conference of Delegates of Corresponding Societies.—Opening Address by Sir Thomas H. Holland, K.C.I.E., D.Sc., F.R.S., President of the Conference.
Section I.—Physiology.—Opening Address by Prof. W. M. Bayliss, M.A., D.Sc., F.R.S., President of the Section.
Section L.—Educational Science.—Opening Address by Mrs. Henry Sidgwick, President of the Section.
Notes.
Our Astronomical Column.
American Hydroids. By S. J. H.
University and Educational Intelligence.
Societies and Academies. **Books Received.**

Copies can be obtained through any bookseller or newsagent, or post-free from the Publishers, St. Martin's Street, London, W.C., on receipt of 6½*d.* from residents in the British Isles, or of 7½*d.* from residents abroad.

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NEW SOUTH WALES, AUSTRALIA.

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Applications are invited from candidates qualified for the above position. Salary (fixed) £900 per annum, and £100 allowed for travelling expenses to Sydney. Pension of £400 per annum under certain conditions after twenty years' service. Duties commence not later than March 1, 1916.

Particulars may be obtained from the undersigned, to whom applications, stating age and qualifications, and accompanied by references and ten copies of recent testimonials, should be sent not later than Wednesday, October 13, 1915.

AGENT-GENERAL FOR NEW SOUTH WALES.

123 Cannon Street,
London, E.C.,
September 21, 1915.

DEWSBURY TECHNICAL SCHOOL.

Organising Master—Mr. H. J. Taylor, F.C.S.

WANTED IMMEDIATELY, ASSISTANT SCIENCE TEACHER (Chemistry and Physics). Part day and evening work. Commencing salary £100 per annum.

Forms of application (which must be returned on or before October 2) will be forwarded by the undersigned upon receipt of stamped addressed envelope.

GEO. E. FEATHERSTON,
Secretary and Clerk to the Governors.

Technical School, Dewsbury,
September 15, 1915.

RADNORSHIRE EDUCATION COMMITTEE.

LLANDRINDOD WELLS INTERMEDIATE SCHOOL.

A MASTER or MISTRESS, with high qualifications in Mathematics, is required for the above Secondary School immediately. The post is temporary, and is vacant through the recent holder having obtained an engagement at Nobel's Munition Works for the period of the war. Salary £150 per annum, non-resident. Applications, with copies of testimonials and references, to be sent to the Head Master.

NORTHAMPTON POLYTECHNIC INSTITUTE,

280 ST. JOHN STREET, LONDON, E.C.

DEPARTMENT OF TECHNICAL OPTICS.

Applications are invited for the post of JUNIOR DEMONSTRATOR, full-time. Particulars and application forms, which should be returned not later than Wednesday, the 29th inst., can be obtained on application to

R. MULLINEUX WALMSLEY, D.Sc.,
Principal.

For other Official Advertisements see pages xxviii *and* xxix.

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DEWSBURY TECHNICAL SCHOOL.

Organising Master—Mr. H. J. Taylor, F.C.S.

WANTED IMMEDIATELY, LECTURER IN CHEMISTRY. Part day and evening work. Salary £165 per annum.

Forms of application (which should be returned at once) will be supplied by the undersigned upon receipt of stamped addressed envelope.

GEO. E. FEATHERSTON,
Secretary and Clerk to the Governors.

Technical School, Dewsbury,
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RESEARCH CHEMIST wanted for works manufacturing fine chemicals. Reply, stating qualifications, age, experience and salary required, to "Research," Box 410, T. B. Browne's Advertising Offices, 163 Queen Victoria Street, E.C.

The Prize Fellowship (£100) offered by the Federation of University Women has been awarded to Miss M. Wheldale, Newnham College, Cambridge.

For other Official Advertisements see pages xxxvi *and* xxxvii.

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NATURE.

The number for **last week (Sept. 23)** contained:—

The Citizen and the State. By A. E. Crawley.
Chemistry and the Microscope. By Dr. A. E. H. Tutton, F.R.S.
Mathematical Theory and Physics.
Our Bookshelf.
Letters to the Editor:—
Magnetic Measurements.—W. H. F. Murdoch; "The Reviewer."—Nodules on the Intermediate Bladderwort.—Harold Evans.
Notes on Stellar Classification.—III. By Sir Norman Lockyer, K.C.B., F.R.S.—**The Attacks of Birds upon Fruit.** By Walter E. Collinge.—**The Canadian Arctic Expedition.** By R. N. R. B.—**The Standards and Functions of Museums.** (*Illustrated.*) By W. P. P.—**Forthcoming Books of Science.**—**The British Association:—Section C.—Geology.**—Opening Address by Prof. Grenville A. J. Cole, F.G.S., M.R.I.A., President of the Section.—**Section E.—Geography.**—Opening Address by Major H. G. Lyons, D.Sc., F.R.S., President of the Section.
Notes. **Our Astronomical Column.**
University and Educational Intelligence.
Societies and Academies. **Books Received.**

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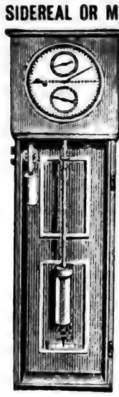

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AND 4 ROYAL EXCHANGE, LONDON.

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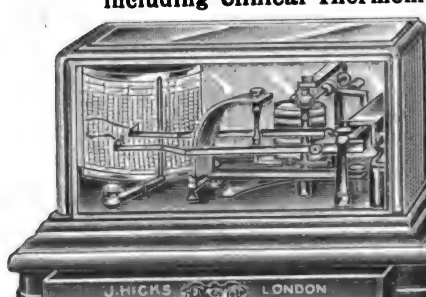

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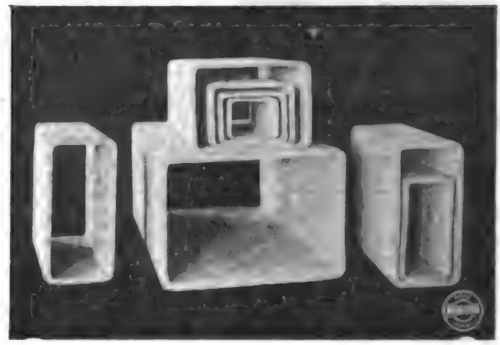

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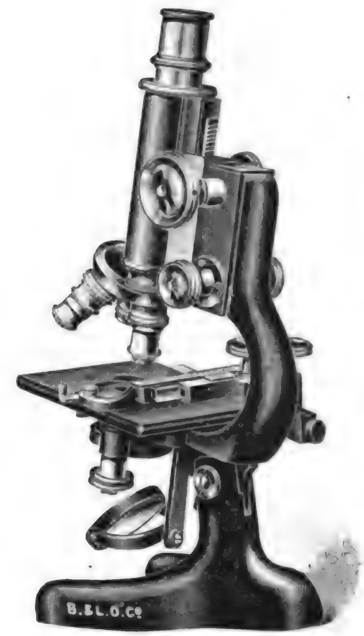

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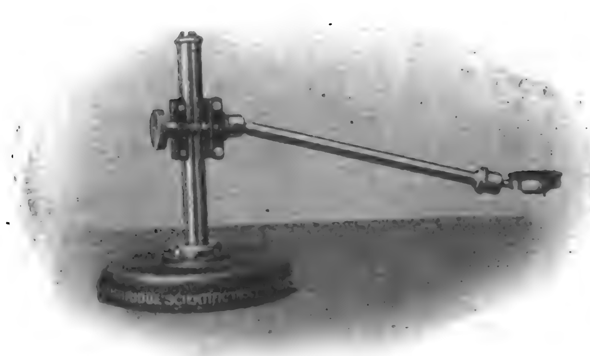

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No. 2398, VOL. 96] THURSDAY, OCTOBER 14, 1915 [PRICE SIXPENCE

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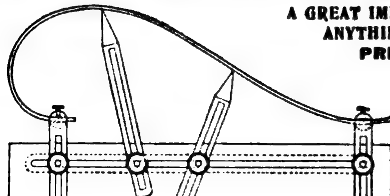

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The number for **last week (Oct. 14)** contained :—

Beauty and Design in Nature.
Lime-Sand Bricks and Allied Products. By J. A. A.
The Panama Canal. By V. C.
Our Bookshelf.
Letters to the Editor:—
The Manganese-Ore Requirements of Germany. Dr. L. LEIGH FERMOR.—Jupiter's Two Principal Markings. SCRIVEN BOLTON.—The Orionid Meteoric Shower. W. F. DENNING.—Visibility of Distant Objects in Warfare. "ARTILLERY OBSERVING OFFICER."—Distances at which Sounds of Heavy Gun-firing are Heard. Lieut.-Col. H. H. GODWIN-AUSTEN, F.R.S.; Dr. CHARLES DAVISON.—The late Prof. E. A. Minchin on "The Evolution of the Cell." EDWARD HERON-ALLEN.
Death from Static Changes in Atmospheric Pressure. By Dr. J. S. HALDANE, F.R.S.
Dr. J. Medley Wood.
Notes.
Our Astronomical Column.
Family Histories and Eugenics.
Character and Intelligence.
Science in the War and After the War. By Prof. J. A. FLEMING, F.R.S.
The British Association:—
Section D.—Zoology.—Opening Address by Prof. E. A. MINCHIN, M.A., Hon. Ph.D., F.R.S., President of the Section.
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"The War—and After."—Sept. 10.
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"Germany's Aims and Ambitions."—Oct. 8.
"The Cultivation of Medicinal Plants in England."—Oct. 15.
"The Sea Fisheries and the War."—Oct. 22.
"Science and the State."—Oct. 29.
"The Place of Science in Industry."—Nov. 12.
"The Supply of Pitwood."—Dec. 10.
"Effects of the War on Scientific Undertakings."—Dec. 10.
"High Explosives in Warfare."—Dec. 24.
"The Manufacture of Dyestuffs in Britain."—Jan. 21.
"Synthetic Drugs in Great Britain."—Jan. 28.
"The Manufacture of Dyestuffs."—Feb. 11.
"Chemistry and Industry."—Feb. 18.
"The Manufacture of Dyestuffs."—Feb. 25.
"The Sea Fisheries and the War."—Feb. 25.
"Duty-free Alcohol for Scientific Purposes."—Mar. 4.
"The Chemical Industries of Germany."—Mar. 11.
"Science and Industry."—Mar. 18.
"Periscopes."—Mar. 18.
"Oil of Vitriol as an Agent of 'Culture.'"—Mar 18.
"Scientific Factors of Industrial Success."—Mar. 25.
"Supplies of Laboratory and Optical Glass Apparatus."—Mar. 25.
"The War and British Chemical Industry."—April 1.
"The Position of the Organic Chemical Industry."—April 1.
"British Supply of Drugs and Fine Chemicals."—April 15.
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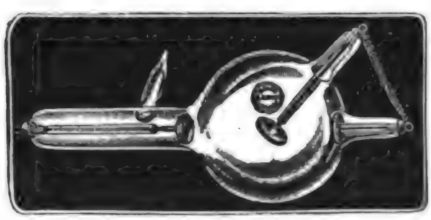

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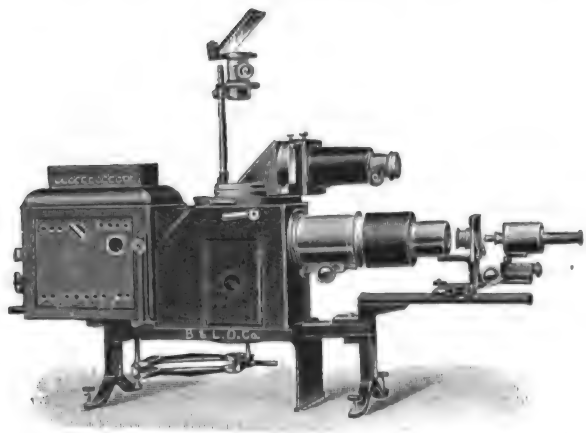

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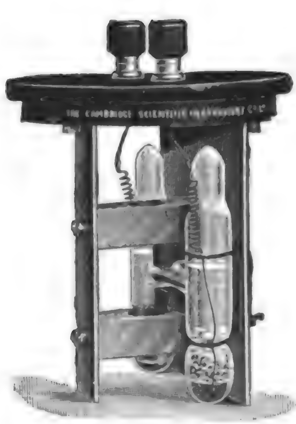

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NO. 2402, VOL. 96] THURSDAY, NOVEMBER 11, 1915 [PRICE SIXPENCE

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CHEMICAL SOCIETY RESEARCH FUND.

A meeting of the Research Fund Committee will be held in December next. Applications for grants, to be made on forms which can be obtained from the Assistant Secretary, must be received on, or before, Wednesday, December 1, 1915.

All persons who received grants in December, 1914, or in December of any previous year, whose accounts have not been declared closed by the Council, are reminded that reports must be in the hands of the Honorary Secretaries not later than Wednesday, December 1.

The Council wish to draw attention to the fact that the income arising from the donation of the Worshipful Company of Goldsmiths is to be more or less especially devoted to the encouragement of research in inorganic and metallurgical chemistry. Furthermore, that the income due to the sum accruing from the Perkin Memorial Fund is to be applied to investigations relating to problems connected with the coal-tar and allied industries.

SWINEY LECTURES ON GEOLOGY, 1915.

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GRESHAM LECTURES.

The Gresham Lecturer on Astronomy, Mr. ARTHUR R. HINKS, M.A., F.R.S., will deliver a Course of Four Lectures on Navigation and Maps on Tuesday, Wednesday, Thursday, Friday, November 16, 17, 18, 19, commencing at 6 p.m., at Gresham College, Basinghall Street, E.C. Lecture 1—Historical, The Time of Gresham. Lecture 2—The Map of Europe. Lecture 3—The Map of Europe (continued). Lecture 4—The Names on the Map of Europe. The Lectures are Free to the Public.

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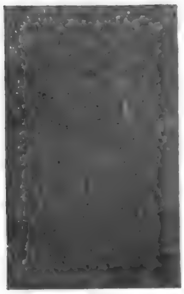

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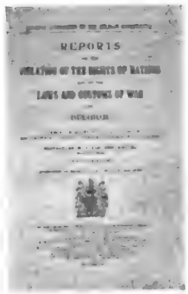

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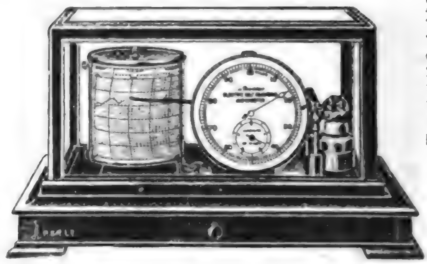

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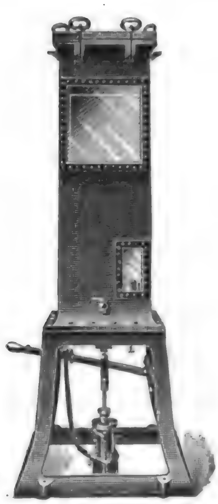

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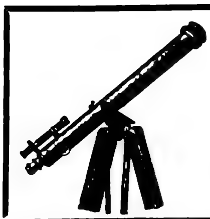

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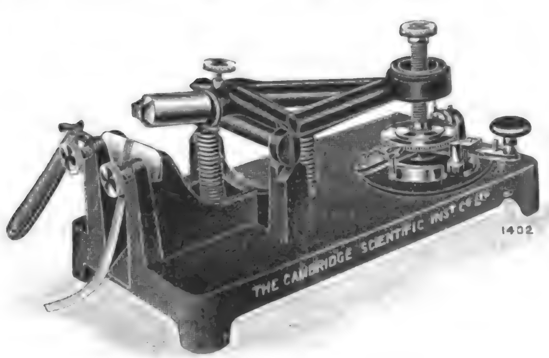

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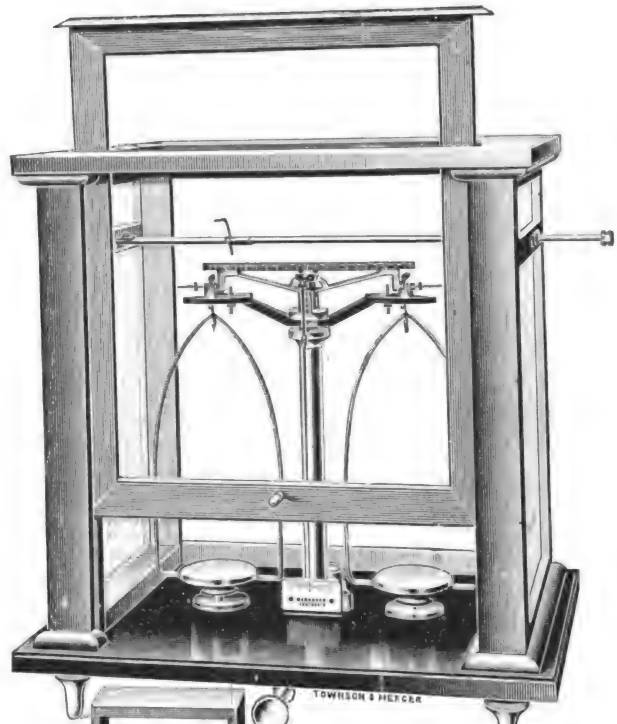

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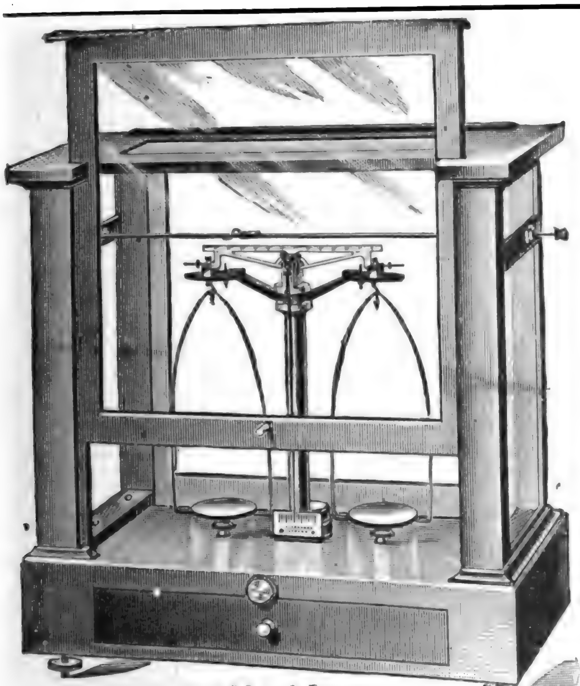

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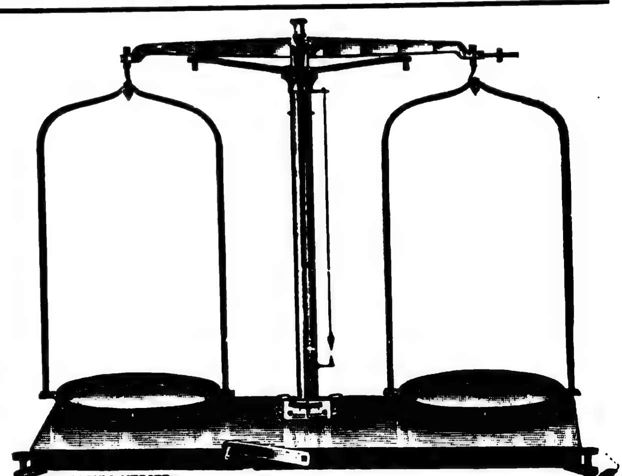

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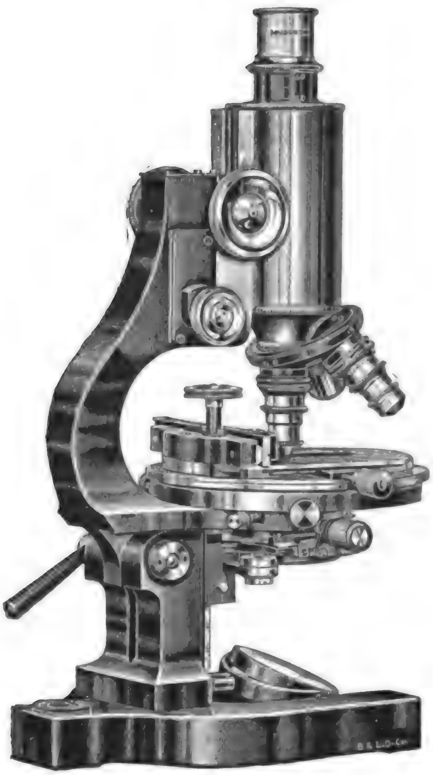

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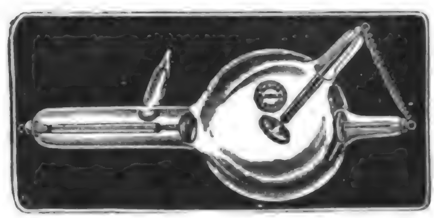

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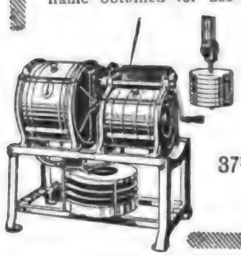

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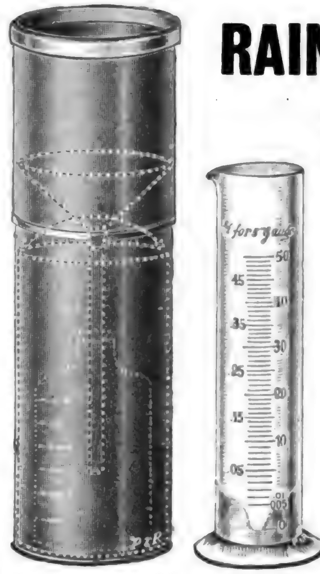

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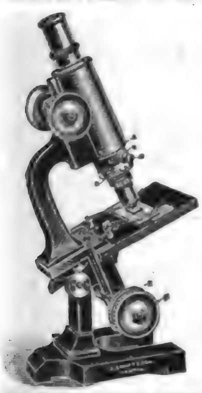

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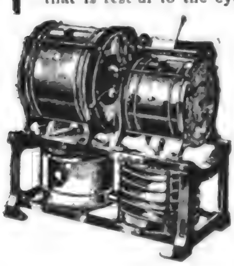

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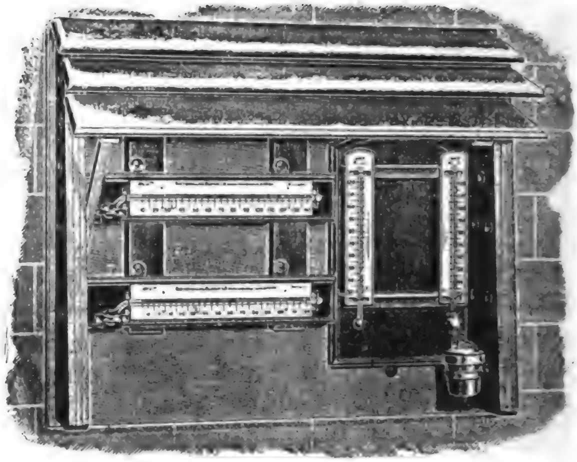

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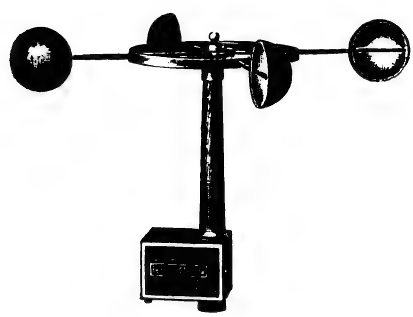

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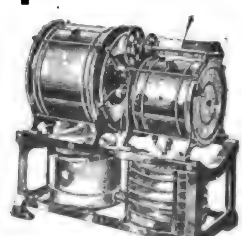

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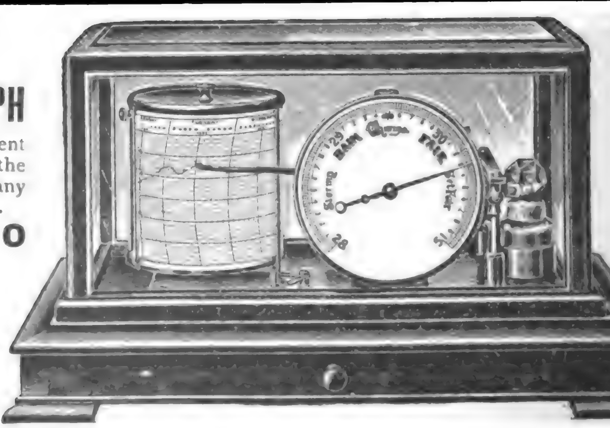

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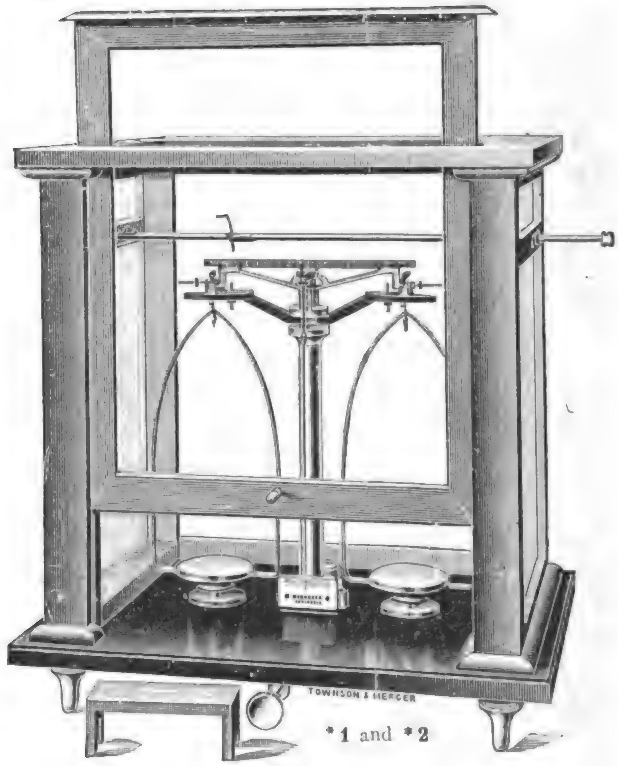

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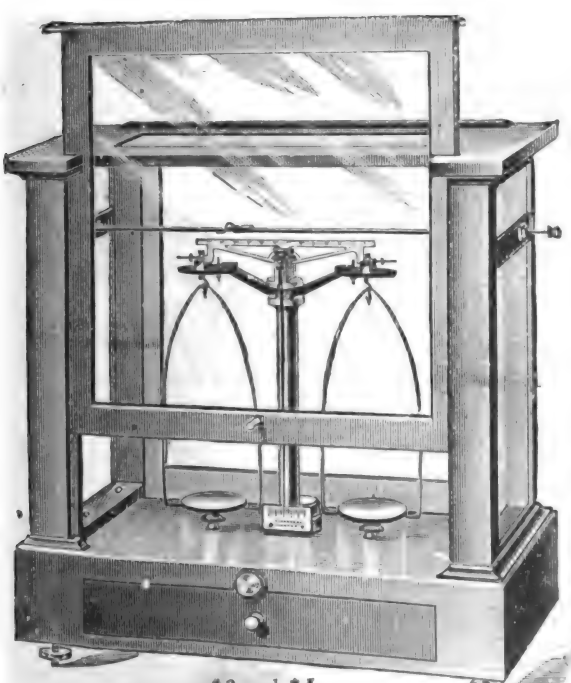

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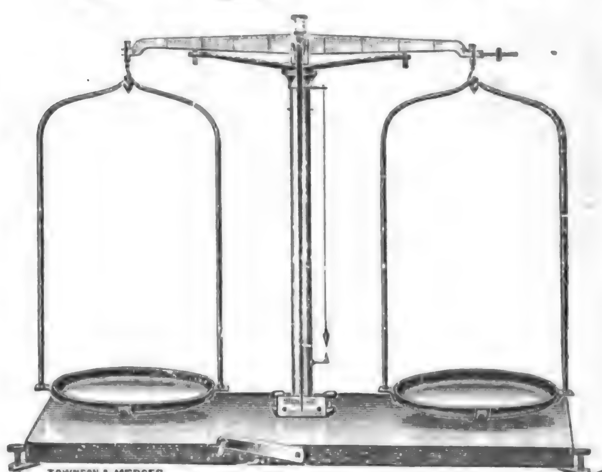

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